

IMPLEMENTATION GUIDE

for use with

10 CFR Part 850,

CHRONIC BERYLLIUM DISEASE PREVENTION PROGRAM

1. PURPOSE AND APPLICABILITY

The purposes of this Guide are to provide supplemental information and describe implementation practices to assist responsible employers in effectively developing, managing, and implementing a chronic beryllium disease prevention program (CBDPP) that is consistent with requirements specified in Title 10 of the Code of Federal Regulations (CFR), Part 850 (10 CFR 850), “Chronic Beryllium Disease Prevention Program.” Title 10 CFR 850 is promulgated pursuant to the Department of Energy’s (DOE) authority under section 161 of the Atomic Energy Act of 1954. This Guide supersedes DOE G 440.1-7, IMPLEMENTATION GUIDE FOR USE WITH DOE N 440.1, INTERIM CHRONIC BERYLLIUM DISEASE PREVENTION PROGRAM, dated 3-30-98.

Specifically, this Guide discusses the regulatory requirements of 10 CFR 850, provides cross-references to DOE directives and industry consensus standards that contain detailed guidance for implementing specific requirements in 10 CFR 850, and provides explanations, with examples, of how to meet the basic requirements for developing and implementing a CBDPP.

Title 10 CFR 850 applies to DOE/NNSA offices and DOE/NNSA contractors with responsibility for operations or activities that involve present or past exposure, or the potential for exposure, to beryllium at DOE/NNSA facilities. It also applies to any current DOE/NNSA employee, DOE/NNSA contractor employee, or any other current worker at a DOE/NNSA facility who is or was exposed or potentially exposed to beryllium at a DOE/NNSA facility.

Except for the few DOE/NNSA-operated facilities, DOE/NNSA Federal workers are not usually directly involved in production tasks or other activities in which they would be exposed to airborne beryllium. However, in performing management and oversight duties, DOE/NNSA Federal workers may enter facilities where beryllium is handled. These Federal workers who also are potentially exposed to beryllium include DOE/NNSA workers who work for DOE/NNSA line programs in the field (e.g., contract oversight personnel), DOE/NNSA workers who work for support programs in the field (e.g., material and equipment management personnel), and DOE/NNSA workers who work for DOE/NNSA line or support programs at headquarters (e.g., program and quality assurance personnel).

Federal agencies are required to ensure the protection of Federal workers under the health and safety provisions of 29 CFR Part 1960, “Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters,” as well as Executive Order 12196, “Occupational Safety and Health Programs for Federal Employees.” DOE’s intent in 10 CFR 850.2(a)(1) is to supplement these general worker protection requirements with specific beryllium-related requirements in the limited instances where DOE/NNSA Federal workers may have the potential for beryllium exposure.

Title 10 CFR 850.2(a)(2) specifies that the rule also applies to DOE/NNSA contractors with operations or activities involving exposure or the potential for exposure to beryllium. As clarified in the definition of a DOE/NNSA contractor (10 CFR 850.3), DOE's intent is that the contractors covered under this rule include any entity under contract to DOE that has responsibility for performing beryllium activities at DOE/NNSA-owned or -leased facilities, including contractors awarded management and operating contracts, integrating contractors, and subcontractors. This section further clarifies that the requirements of the CBDPP apply only to contractors and subcontractors responsible for operations or activities that involve the potential for worker exposure to beryllium.

Title 10 CFR 850 does not apply to former DOE workers, to activities at DOE/NNSA facilities that do not involve exposures or potential exposures to beryllium, or to activities not conducted at a DOE/NNSA facility (such as the off-site laundering of beryllium-contaminated protective clothing from a DOE/NNSA facility). The CBDPP does not apply to beryllium articles or DOE/NNSA laboratory operations involving beryllium subject to the requirements of 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (ref. 1). Note that a beryllium article that is subjected to any activity (machining, forming, firing, lapping, etc.) that could result in the release of beryllium or an exposure to airborne beryllium is no longer considered to be a beryllium article.

The Occupational Safety and Health Administration (OSHA) describes laboratory operations for the purposes of 29 CFR 1910.1450(b) by the following definitions.

- "Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
- "Laboratory scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. Laboratory scale excludes those workplaces whose function is to produce commercial quantities of materials.
- "Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met:
 - chemical manipulations are carried out on a "laboratory scale";
 - multiple chemical procedures or chemicals are used;
 - the procedures involved are not part of a production process, nor in any way simulate a production process; and
 - "protective laboratory practices and equipment" are available and in common use to minimize the potential for worker exposure to hazardous chemicals.
- "Protective laboratory practices and equipment" means those laboratory procedures, practices, and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for worker exposure to hazardous chemicals.

- Furthermore, 29 CFR 1910.1450 does not apply to quality control or quality assurance laboratories, or to pilot plants, that support production processes.

The laboratory exemption applies only in instances where relatively small quantities of beryllium are used in a non-production activity. Most DOE/NNSA operations involving beryllium, including operations in DOE/NNSA national laboratories, would not be considered laboratory operations by OSHA's definitions and therefore would not be exempt from 10 CFR 850. DOE assumes that its laboratories that are exempt from 10 CFR 850 are complying with 29 CFR 1910.1450 when using small quantities of beryllium.

In this Guide, the word "must" designates requirements from 10 CFR 850. The words "should" and "may" denote optional program recommendations and allowable alternatives, respectively.

This Guide provides DOE's views on acceptable methods of program implementation and is not mandatory. DOE believes that this Guide can serve as an effective tool in meeting the minimum regulatory requirements of 10 CFR 850. Conformance with this Guide will provide reasonable assurance that the responsible employer has complied with the related regulatory requirements. DOE encourages its contractors and organizational elements to go beyond minimum regulatory requirements and to pursue excellence in their programs. Alternate methods that are demonstrated to provide an equivalent or better level of protection are acceptable.

DOE/NNSA Federal and contractor personnel, and workers and their representatives, who would like clarification of the rule beyond what is found in this Guide, may submit a request to DOE's Worker Safety and Health Standards Response Line at—

<http://www.eh.doe.gov/rl/>

Response Line responses clarify rule requirements and intent. The rule contains exemptions, discussed above, but does not contain a provision for requesting additional exemptions or any other type of exceptions. Requests for interpretation of the rule that exceed the bounds of clarification will be forwarded to DOE's Office of General Counsel for a formal legal interpretation.

Enforcement of 10 CFR 850 is effected through contractual remedies. Title 10 CFR 850.4 provides that DOE may take appropriate steps under its contracts to ensure compliance with the rule, including (but not limited to) contract termination or reduction in fee. These steps would necessarily vary as a function of the contract, the CBDPP component of the contract, and the compliance issue. An enforcement action should—

- identify the specific beryllium activity or condition of beryllium exposure at issue,
- identify the section of the rule that addresses the activity or condition, and
- if appropriate, discuss why the rule requirement has not been met and any protective measures taken to compensate for not meeting the requirement.

2. DEFINITIONS

Terms defined in 10 CFR 850 are used in this Guide consistent with their regulatory definitions.

The rule defines several terms (e.g., beryllium activity, beryllium-associated worker, beryllium emergency, operational area, and regulated area) in performance-based language. The rule also uses other performance-based terms (e.g., significant change), as those terms are commonly understood. These definitions and terms use expressions such as “can expose,” “may have been exposed,” “significant release,” “in the presence of beryllium,” “reasonably be expected to exceed,” and “significant change” that provide the flexibility necessary for a performance-based rule. Title 10 CFR 850 also is performance based in the use of the action and removable surface contamination levels since the rule does not specify the statistical tools to be used in comparing sampling results to these levels.

Title 10 CFR 850.11, “General CBDPP Requirements,” requires that the CBDPP be commensurate with the hazard of the activities performed. The use of the rule’s performance-based terms should be applied commensurate with the facilities’ specific beryllium hazards and the terms should have clear meaning and intent in the DOE-approved CBDPPs. The key considerations for using these terms are that they are applied within the parameters of the rule, are agreed upon in a DOE-approved CBDPP, are explained in a rationale that is included in the CBDPP, and are subject to headquarters oversight. Performance-based terms should be used in a manner that supports the rule’s fundamental objectives of reducing and minimizing exposure, and quickly detecting medical signs or symptoms of disease.

3. DISCUSSION

Title 10 CFR 850 establishes the requirements for the development and implementation of a CBDPP. The objectives of the CBDPP are to reduce the number of DOE/NNSA Federal and contractor employees currently exposed to beryllium in the course of their work at DOE/NNSA facilities, minimize the levels of and potential for exposure to beryllium, and establish medical surveillance requirements to ensure early detection that allows for early treatment of the disease.

DOE believes that successful implementation of the CBDPP requires integration into existing worker safety and health programs and initiatives as well as the full inclusion and integration of safety and health into the totality of work, such that it is an integral part of the whole—not a stand-alone program. Integrating the CBDPP can be achieved by applying the integrated safety management (ISM) core functions and guiding principles described in DOE P 450.4, SAFETY MANAGEMENT SYSTEM POLICY (ref. 2). CBDPPs should be integrated into worker protection program requirements, such as DOE O 440.1A, WORKER PROTECTION MANAGEMENT FOR DOE FEDERAL AND CONTRACTOR EMPLOYEES (ref. 3). Table 1 shows how this rule integrates with other DOE worker protection requirements and guidance.

To assist responsible employers with the integration objective, Appendix A provides a crosswalk for the guidance in this Guide to 10 CFR 850 and the directives and guidance contained in DOE O 440.1A and its Implementation Guides. Additionally, Table 2 depicts the relationships between CBDPP requirements and the ISM core functions.

Title 10 CFR 850 requires that specific CBDPP elements [i.e., 10 CFR 850.20(c)(1), 10 CFR 850.21(b)(1), and 10 CFR 850.24(a)(1)] be managed by a qualified individual [e.g., a certified industrial hygienist (CIH)]. This applies to both DOE/NNSA contractor and DOE/NNSA responsible employers. The CIH designation is one way to ensure that the manager possesses sufficient knowledge of industrial hygiene. However, a CIH is not required. Title 10 CFR 850 does not require the responsible employer to formally demonstrate that the qualified individual possesses qualifications equivalent to a CIH. Each responsible employer is free to make this determination about qualifications. However, the rule indicates that a CIH is an example of a qualified individual so responsible employers should designate CIHs or similarly qualified individuals for this position. Practically speaking, responsible employers must have access to competent industrial hygienists for the CBDPP to be successful. Responsible employers should ensure that their industrial hygiene staffs—

- are adequately trained in the anticipation, recognition, evaluation, and control of hazardous and potentially hazardous occupational exposures, and
- have the support necessary to maintain and enhance the staff's proficiency in industrial hygiene through continued training, professional education, and professional activities (e.g., the professional certification process).

Because industrial hygienists have widely varying backgrounds, experience, talent, and education, their development programs should be individualized. Within the worker protection field, opportunities exist for cross training among the various disciplines. For example, an industrial hygienist may benefit from cross training in health physics, environmental protection, occupational safety, and waste management, as well as from management training in administration, budgeting, and strategic planning.

The industrial hygiene aspects of the worker protection program should be directed by a senior industrial hygienist with appropriate experience, who should report directly to a senior member of management. A senior industrial hygienist is either certified in the practice of industrial hygiene by the American Board of Industrial Hygiene (ABIH) or meets the ABIH requirements for certification. At a minimum, a senior industrial hygienist must have a college or university degree in industrial hygiene or a related scientific, engineering, or technical degree; special studies and training; and 5 years of full-time employment in the professional practice of industrial hygiene.

Table 1. DOE Worker Protection Requirements and Guidance**STATUTES**

- Atomic Energy Act of 1954
- Energy Reorganization Act of 1974
- Department of Energy Organization Act of 1977
- Energy Policy Act of 1992
- 42 USC Section 7274i, Program to Monitor Department of Energy Workers Exposed to Hazardous and Radioactive Substances
- Privacy Act of 1974
- Freedom of Information Act of 1966
- Americans with Disabilities Act of 1990

REGULATIONS

- 10 CFR 850, Chronic Beryllium Disease Prevention Program
- 10 CFR 835, Occupational Radiation Protection
- 10 CFR 602, Epidemiology and Other Health Studies Financial Assistance Program
- 48 CFR 970, Department of Energy Acquisition Regulations
- 10 CFR 830, Nuclear Safety Management
- 10 CFR 820, Procedural Rules for DOE Nuclear Activities
- 10 CFR 708, DOE Contractor Employee Protection Program
- 10 CFR 707, Workplace Substance Abuse Programs at DOE Sites

DOE REQUIREMENTS IMPLEMENTED THROUGH CONTRACTS

- DOE P 450.4, Safety Management System Policy
- DOE M 411.1-1A, Safety Management Function, Responsibilities, and Authorities

Worker Safety Functions

- DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees
- DOE M 440.1-1, Explosives Safety Manual
- DOE O 442.1, DOE Employee Concerns Program
- DOE O 440.2, Aviation
- DOE O 225.1A, Accident Investigation
- DOE O 231.1, Environment, Safety, and Health Reporting

Nuclear and Other Safety Functions

- DOE O 420.1, Facility Safety
- DOE O 420.2, Safety of Accelerator Facilities
- DOE O 425.1A, Startup and Restart of Nuclear Facilities
- DOE O 414.1A, Quality Assurance
- DOE O 460.1A, Packaging and Transportation Safety
- DOE-STD-1098-99, Radiological Control

IMPLEMENTATION GUIDES

- DOE G 440.1-7A, Chronic Beryllium Disease Prevention Program
- DOE G 440.1-1, Worker Protection Management
- DOE G 440.1-4, Occupational Medical
- DOE G 440.1-3, Exposure Assessment
- DOE G 440.1-2, Construction
- DOE G 440.1-5, Fire Protection
- DOE G 440.1-6, Suspect/Counterfeit Items
- DOE G 421.1-1, DOE Good Practices Guide
- DOE G 441.1, Series 1 through 13, addresses various aspects of radiation protection program management and administration

Table 2. Relationships Between 10 CFR 850 Requirements and ISM Core Functions

10 CFR 850 Program Requirement	ISM Core Functions				
	Define Scope of Work	Identify Hazards	Establish Controls	Perform Work	Provide Feedback
Baseline beryllium inventory	✓	✓			
Hazard assessment		✓			
Exposure limits			✓		
Action level	✓		✓		
Exposure monitoring			✓	✓	✓
Exposure reduction and minimization			✓	✓	
Regulated areas			✓		
Hygiene facilities and practices			✓		
Respiratory protection			✓		
Protective clothing and equipment			✓		
Housekeeping		✓	✓	✓	
Release criteria			✓	✓	
Waste disposal			✓	✓	
Beryllium emergencies			✓		
Medical surveillance			✓	✓	
Medical removal			✓	✓	
Medical consent			✓	✓	
Training and counseling			✓	✓	
Warning signs and labels			✓		
Recordkeeping and use of information			✓	✓	✓
Performance feedback					✓

All of the CBDPP requirements are mandatory, but the performance-based nature of the rule provides for a graded approach to the development and implementation of many of the program elements. Figures 1a and 1b are flowcharts that depict an example of implementing CBDPP requirements.

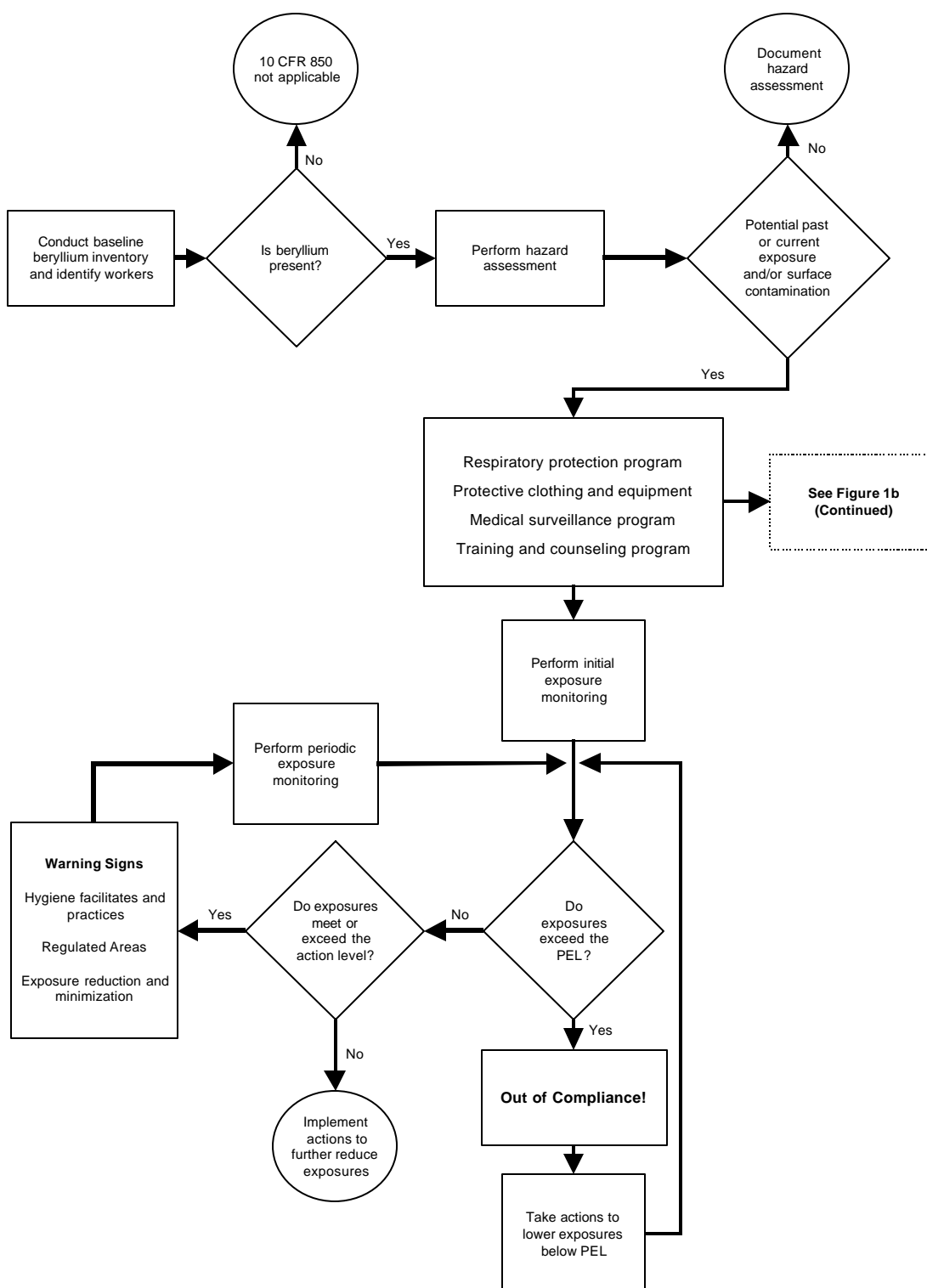
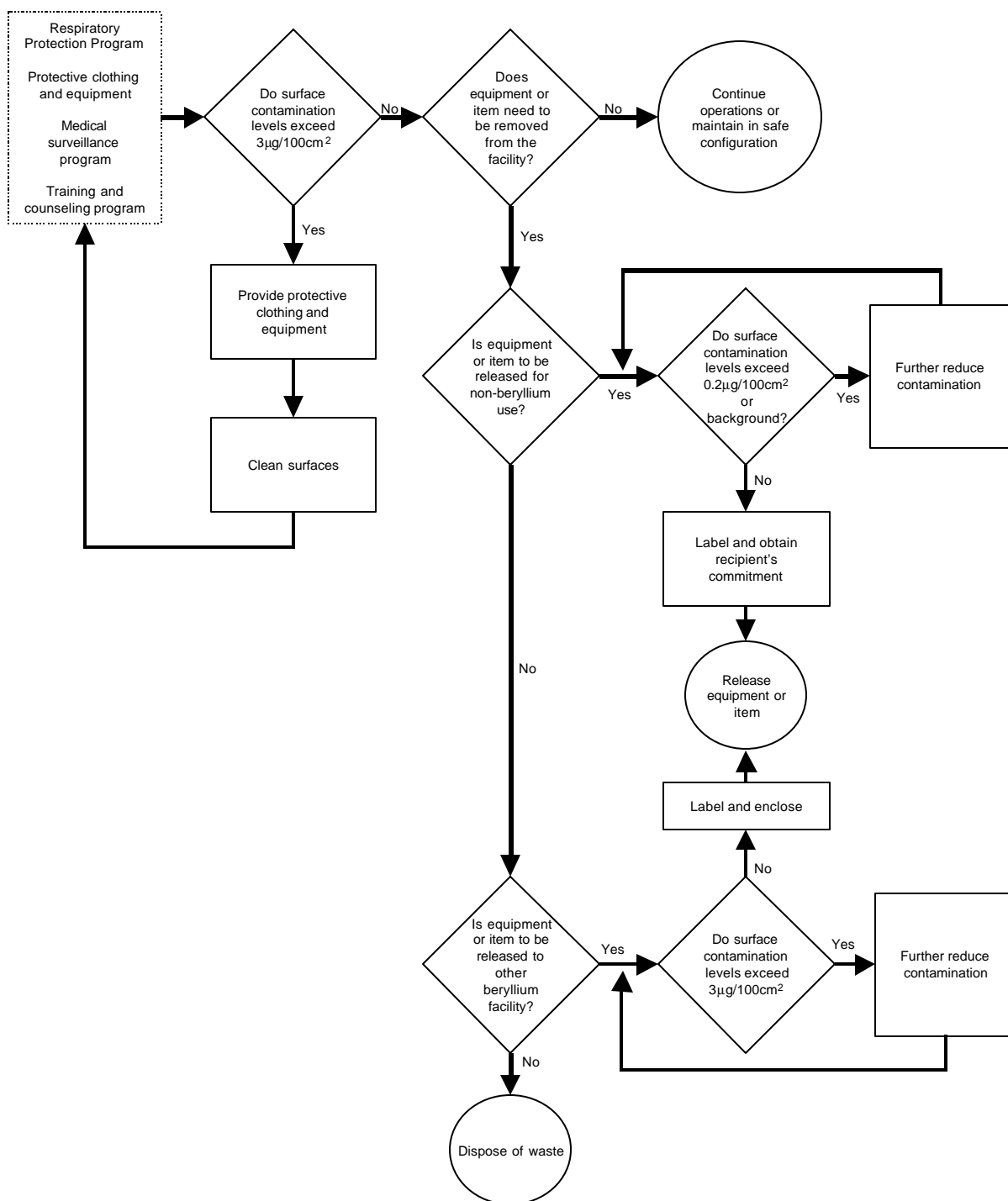


Figure 1b. Example CBDPP Process

Figure 1a Continued**Figure 1b. Example CBDPP Process (continued).**

An industrial hygiene technician should have, at a minimum, a high school diploma, special studies and training in the field of industrial hygiene, and 5 years of experience under a senior industrial hygienist. Appropriate introductory-level college courses can serve as the equivalent of 1 year of experience, and an appropriate associate's degree can serve as the equivalent of 2 years of experience. [See the ABIH *Bulletin*, dated 4-13-97 (ref. 4) for detailed requirements for certification or eligibility for certification.]

DOE G 440.1-4, CONTRACTOR OCCUPATIONAL MEDICAL PROGRAM GUIDE FOR USE WITH DOE O 440.1 (ref. 5), describes professional qualifications for medical staff (see Appendix A for relevant citations). In addition, the DOE "Industrial Hygiene Functional Area Qualification Standard" (Rev. 1) may be used to establish the qualifications of industrial hygienists. This standard can be found at—

<http://cted.inel.gov/cted/qualstd.html>

as well as under the designation, DOE-STD-1138-2000, on the DOE Technical Standards web site at—

<http://www.eh.doe.gov/techstds/standard/standfrm.html>

4. IMPLEMENTATION GUIDANCE

The following subsections contain supplemental explanations and examples of strategies for developing and implementing specific elements of the CBDPP.

4.1 Chronic Beryllium Disease Prevention Program

Title 10 CFR 850.10 requires responsible employers to ensure that a CBDPP is prepared and submitted to the head of the appropriate DOE/NNSA field element before beginning beryllium activities, but no later than April 6, 2000 [10 CFR 850.10(a)]. A responsible employer¹ is defined as follows:

- for DOE/NNSA contractor employees, the DOE/NNSA contractor office that is directly responsible for the safety and health of DOE/NNSA contractor employees while performing a beryllium activity or other activity at a DOE/NNSA facility;
- for DOE/NNSA employees, the DOE/NNSA office directly responsible for the safety and health of DOE/NNSA Federal employees who are performing a beryllium activity or other activity at a DOE/NNSA facility;
- any person acting directly or indirectly for such office with respect to terms and conditions of employment of beryllium-associated workers.

DOE N 440.1, INTERIM CHRONIC BERYLLIUM DISEASE PREVENTION PROGRAM, has been superseded by the rule and canceled. Employers initially covered by DOE N 440.1 should

¹The terms "employer" and "employers" are used throughout this Guide to mean "responsible employer" and "responsible employers" as defined in 10 CFR 850.

experience no interruption of beryllium activities under their approved CBDPP required by either the Notice or the rule. Employers may wish to simply revise and refine the CBDPP that was developed in response to DOE N 440.1 to conform to the rule. If the CBDPP has separate sections addressing the activities of multiple contractors at the facility, the head of the DOE/NNSA field element must designate a single DOE/NNSA contractor to review and approve the sections prepared by other contractors, so that a single consolidated CBDPP for the facility is submitted to the head of the DOE/NNSA field element for review and approval [10 CFR 850.10(a)(2)].

The head of the appropriate DOE/NNSA field element must review and approve the CBDPP [10 CFR 850.10(b)]. The field element should have, or should have access to, a qualified individual to assist in reviewing the technical features of the CBDPP (see section 3 of this Guide). The initial CBDPP and any updates are deemed approved 90 days after submission if they are not specifically approved or rejected by DOE/NNSA earlier. Each employer must furnish a copy of the approved CBDPP, upon request, to the DOE Assistant Secretary for Environment, Safety and Health or designee, DOE/NNSA program offices, and affected workers or their designated representatives. Employers must submit an update of the CBDPP to the head of the appropriate DOE/NNSA field element for review and approval whenever a significant change or significant addition to the CBDPP is made or a change of contractors occurs.

“Significant change or addition” is a performance-based term. Refer to section 2 of this Guide for a discussion of performance-based terms in the context of a performance-based rule such as 10 CFR 850. The employer and the head of the DOE/NNSA field element determine, based on hazard assessments, if changes or additions are significant enough to warrant changing the CBDPP. The employer must submit to the head of the DOE/NNSA field element for approval only those sections of the CBDPP that have changed.

Due to the wide range of beryllium activities subject to 10 CFR 850 and the variety of control methods used to ensure compliance, no specific criteria exist by which DOE can predetermine whether a change to the CBDPP is required. Factors that should be considered include the following:

- mission changes, such as in—
 - amount of beryllium,
 - processes and work practices,
 - control systems,
 - form of beryllium,
 - number of beryllium-associated workers, and
 - presence of beryllium in occupied areas;
- medical surveillance findings of sensitization and disease;
- performance indicators, such as—
 - individual and group exposures,
 - occurrence trends determined from analyses of Occurrence Reporting and Processing System (ORPS) reports,

- medical trends from beryllium registry studies,
 - exposure trends, and
 - individual occurrences;
- administrative considerations, such as—
 - worker awareness of conditions and controls,
 - level of management oversight of routine and non-routine work activities involving beryllium,
 - sufficiency of monitoring programs, and
 - completeness and retrievability of records;
- other factors that would affect full compliance with the CBDPP.

The head of the DOE/NNSA field element must review the CBDPP at least annually and, if necessary, require the employer to update the CBDPP.

If an employer employs or supervises beryllium-associated workers represented for collective bargaining by a labor organization, the employer must give the labor organization timely notice concerning development and implementation of the CBDPP and any revisions. However, DOE promulgated 10 CFR 850 pursuant to the Agency's authority under section 161 of the Atomic Energy Act to prescribe such regulations as it deems necessary to govern any activity authorized by the Atomic Energy Act, specifically including standards for the protection of health and the minimization of danger to life or property [42 U.S.C. section 3301(i)(3) and (p)]. DOE has concluded that there is a compelling need for the CBDPP requirements in the regulation in order for DOE to meet its obligation under the Atomic Energy Act to protect the health of its employees and other workers at DOE/NNSA facilities. For this reason, the regulatory requirements of this regulation will apply by operation of law to DOE contracts. This means that DOE's decisions in the rule regarding the minimum requirements in the regulation are non-negotiable and may not be waived. However, the regulation does not preclude all collective bargaining on other matters related to beryllium exposure protections. For example, DOE's objectives of controlling worker exposure to airborne beryllium and obtaining better exposure data would be defeated if the minimum accuracy of monitoring were subject to collective bargaining.

Similarly, parties are free to collectively bargain stricter standards for worker protection. Further, some regulatory provisions, such as the requirement for a beryllium exposure reduction and minimization provision in an employer's CBDPP, are performance-based and allow for negotiation between the employer and employee representatives. Where workers are represented for purposes of collective bargaining, in the absence of a waiver of the union's rights, an employer violates that duty to bargain by either (1) unilaterally changing conditions pertaining to workplace exposure to beryllium without notice and bargaining to a good-faith impasse with the collective-bargaining representative of its workers or (2) substantially and materially modifying any collective-bargaining agreement regarding workplace beryllium practices without the agreement of the labor organization.

Title 10 CFR 850.11 establishes CBDPP requirements. DOE's Acquisition Regulation (48 CFR 970) requires DOE/NNSA contractors to comply with applicable safety and health, public protection, and restoration of the environment requirements in Federal rules. Title 10 CFR 850 is an applicable health and safety regulatory requirement; it therefore applies to DOE contracts and, as such, is not subject to the Work Smart Standards program or similar processes. The CBDPP must specify the existing and planned operational tasks that are within the scope of the CBDPP.

The CBDPP must augment and, to the extent feasible, be integrated into the existing worker protection programs that cover activities at the facility. The detail, scope, and content of the CBDPP must be commensurate with the hazard of the activities performed. In all cases however, the CBDPP must include formal plans and measures for maintaining exposures to beryllium at or below the permissible exposure level prescribed in 10 CFR 850.22 and for complying with the medical, counseling, and recordkeeping provisions of 10 CFR 850 for workers with past exposure, or potential exposure, to beryllium at DOE/NNSA facilities. In addition, the CBDPP must satisfy each of the specific program requirements of subpart C of the rule and must contain provisions for—

- minimizing the number of workers exposed and potentially exposed to beryllium;
- minimizing the number of opportunities for workers to be exposed to beryllium;
- minimizing the disability and lost work time of workers due to chronic beryllium disease (CBD), beryllium sensitization, and associated medical care; and
- setting specific exposure reduction and minimization goals that are appropriate for the beryllium activities covered by the CBDPP to further reduce exposure below the permissible exposure limit (PEL) prescribed in 10 CFR 850.22.

Table 3 provides specific criteria for including elements in the CBDPP. As shown in the beryllium operations/locations column, certain CBDPP elements must be included regardless of the exposure level. Examples include baseline inventory, hazard assessment, and initial exposure monitoring. Other specific elements of the CBDPP must be included at exposure levels meeting or exceeding the action level. Examples include periodic monitoring, regulated areas, and hygiene facilities and practices. At exposure levels below the action level, less formality is required and sound judgment is essential in considering further reduction and minimization efforts. Section 4.2.5 provides more detailed guidance on exposure reduction and minimization.

Title 10 CFR 850.12 requires employers to manage and control beryllium exposures in all activities consistent with the approved CBDPP Plan. The rule prohibits the following:

- any DOE/NNSA or DOE/NNSA contractor employee from taking any action inconsistent with 10 CFR 850, an approved CBDPP, or any other Federal statute or regulation concerning beryllium exposures at DOE/NNSA facilities;

Table 3. Levels at Which the Provisions of the CBDPP Apply

Provision	Worker Exposure or Potential Exposure Levels [8-hr time-weighted average (TWA)]		
	Be Operations/ Locations ¹	≥ Action Level	> PEL (8-hr TWA)
Baseline Inventory (850.20)	X		
Hazard Assessment (850.21)	X		
Initial Exposure Monitoring (850.24)	X		
Periodic Exposure Monitoring (850.24)		X	
Exposure Reduction and Minimization (850.25)	X ²	X ³	X ⁴
Regulated Areas (850.26)		X	
Hygiene Facilities and Practices (850.27)		X	
Respiratory Protection (850.28)	X ⁵	X	
Protective Clothing and Equipment (850.29)	X ⁶	X	
Housekeeping (850.30)	X ⁷		
Release Criteria (850.31)	X ^{8,9}		
Medical Surveillance (850.34)	X ¹⁰		
Training and Counseling (850.37)	X ¹¹		
Warning Signs (850.38)		X	
<p>Wording in <i>italics</i> is different from the corresponding wording in the same table (Table 8, page 68863) of the rule's preamble in response to comments to improve accuracy and clarity.</p> <p>¹ Applies to beryllium operations and other locations <i>with</i> the potential for beryllium <i>exposure</i>.</p> <p>² <i>Employers</i> must implement actions for reducing and minimizing exposures, if practicable.</p> <p>³ <i>Employers</i> must establish a formal exposure reduction and minimization program, if practicable.</p> <p>⁴ <i>Employers</i> must reduce exposures to or below the <i>permissible exposure limit</i> (PEL).</p> <p>⁵ <i>Employers</i> must provide respirators when requested by the worker.</p> <p>⁶ <i>Employers</i> must provide protective clothing and equipment where surface contamination levels are above 3 ìg/100cm² and when requested by the worker.</p> <p>⁷ Housekeeping efforts must maintain removable surface contamination at or below 3 ìg/100 cm² during non-operational hours.</p> <p>⁸ Removable contamination of equipment surfaces must not exceed 0.2 ìg/100 cm² when released to the public or for non-beryllium use.</p> <p>⁹ Removable contamination of equipment surfaces must not exceed 3 ìg/100 cm² when released to other beryllium handling facilities.</p> <p>¹⁰ <i>Employers</i> must provide medical surveillance for all beryllium-associated workers who voluntarily participate in the program.</p> <p>¹¹ Training is required for all workers who could be potentially exposed. <i>Counseling must be offered</i> to beryllium-associated workers diagnosed with <i>chronic beryllium disease</i> or beryllium sensitization.</p>			

- the initiation of any task that is outside the scope of the CBDPP and that involves potential exposure to airborne beryllium until an updated CBDPP is approved by the head of the DOE/NNSA field element. (In the event of an unexpected situation, the head of the DOE/NNSA field element may approve the task before the CBDPP is updated.)

Title 10 CFR 850 takes a performance-based approach to implementation, and employers are given latitude in choosing the best implementation alternatives for inclusion in their CBDPPs. The rule does not preclude employers from taking any actions they deem necessary to protect the safety and health of workers. Nothing in 10 CFR 850 reduces the responsibilities of DOE/NNSA officials under the Federal employee occupational safety and health program required under 29 CFR Part 1960, “Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters,” and related DOE directives.

Title 10 CFR 850.13 requires full compliance with the rule no later than January 7, 2002. DOE will enforce CBDPP requirements through contractual remedies, including contract termination or reduction in fee. Title 10 CFR 850.5 permits any adversely affected person to refer a dispute regarding compliance with the rule to the Office of Hearings and Appeals for resolution. Employees represented by a labor organization must, however, exhaust any grievance-arbitration procedure that is available for resolving disputes over terms and conditions of employment before filing a petition for relief with the Office of Hearings and Appeals.

4.2 Specific Program Elements

Subpart C of 10 CFR 850 contains 21 sections that constitute the required elements of an acceptable CBDPP.

4.2.1 Baseline Beryllium Inventory

Title 10 CFR 850.20 requires employers to develop a baseline inventory of the locations of beryllium operations and other locations of potential beryllium contamination and identify workers exposed or potentially exposed at those locations. Employers must review current and historical records, conduct interviews with workers, conduct beryllium sampling (air, surfaces, and bulk), and document characteristics and locations of beryllium at the facility. In addition, a qualified individual must manage the baseline beryllium inventory (see section 3 for a discussion of “qualified individual”). Employers must ensure that individuals assigned to inventory tasks have sufficient knowledge and experience to perform such tasks properly [10 CFR 850.20(c)(2)].

Baseline inventory and sampling are the first steps in determining potential beryllium exposures. The baseline inventory and sampling should provide an inventory of activities that may generate hazardous exposures and a list of the potentially exposed workers, preliminary exposure monitoring data, and preliminary exposure profiles of any similarly exposed group of workers that may exist. Included in the inventory is a comprehensive listing of locations where beryllium is located or suspected. The desired outcome is a complete inventory of available information on workers, tasks, materials, and locations that can be reviewed to identify the potential beryllium hazards. The inventory is essential for determining locations that require posting, establishing beryllium-regulated areas, conducting work planning, and establishing standard operating

procedures that result in adequate and appropriate worker protection from beryllium hazards. This information also is vital in identifying workers who may have had past exposures and must be offered medical surveillance (10 CFR 850.34), and if possible, in linking their exposures, tasks, and health outcomes.

4.2.1.1 Records Review

Employers should conduct the records review before performing characterization activities (i.e., sampling). Records review is the first step in developing a baseline inventory and is particularly important for inactive and abandoned facilities that have not recently operated.

Employers should identify all sources of available information about the current and former presence and use of beryllium on site. This may include collection of the following information sources to the extent they are relevant and available:

- rosters of past and present workers in facilities with known usage of beryllium,
- procurement documents,
- ORPS reports and Computerized Accident/Incident Reporting System (CAIRS) reports,
- inventory records,
- process flow diagrams,
- site maps,
- exposure monitoring data,
- surface monitoring data,
- existing hazard analysis documentation,
- Safety Analysis Reports (SARs),
- reports of health studies,
- standard operating procedures,
- facility operating manuals,
- OSHA 200 logs, and
- office correspondence.

Employers should review these records to identify the locations or potential locations of beryllium, the form and quantity of beryllium materials or contamination, and facility areas with the potential for beryllium exposures or contamination. Many of these records may no longer be available at some DOE/NNSA facilities (e.g., facilities that have been shut down or abandoned), but may be available at DOE headquarters and Federal and other records collection centers. Employers should clearly document any gaps in beryllium-related information, so that employee interviews and sampling activities can be organized to focus on these areas.

Most DOE/NNSA facilities have a records manager who can assist in locating beryllium-relevant records. Records managers know what records collections are available and how to access those records. This assistance is especially important for identifying and obtaining historical records that have been placed in archives or records holding areas. Federal agencies are required to

group and store records according to categories, referred to as schedules. Two schedules likely to contain information on beryllium are the Medicine, Health, and Safety Schedule and the Material Accountability Schedule. Other schedules may also contain information on beryllium due to the considerable variability in how different individuals chose to categorize similar records. Some DOE/NNSA facilities have extensive and well-indexed beryllium-relevant records. Oak Ridge, for example, has made available more than 9,000 searchable beryllium-relevant records at the following web site:

<http://www.oakridge.doe.gov/Foia/Beryllium.htm>

DOE headquarters Office of Records, Research, Data and Access, EH-64, provides finding and research aids for a wide variety of subjects at the following web site:

<http://www.eh.doe.gov/workstation/>

The EH-64 web site includes descriptions of collections of beryllium-relevant records stored at locations around the country and an indexed collection of key beryllium-relevant records (including a description of the records) maintained at DOE headquarters.

4.2.1.2 Employee Interviews

Employers should develop an initial list of employees to interview based on results of the facility records review. Interviews should initially target both current and retired employees who have worked in a facility that contained beryllium operations and employees whose work involved storage and transportation of beryllium materials. This also includes workers who were involved in post-operational activities in which exposure to remaining inventory or residual beryllium was possible (e.g., maintenance workers performing routine surveillance in a shutdown contaminated facility). Workers often know of past beryllium activities for which no records exist.

An initial list of employees may include project managers, engineering support personnel, safety and health staff, and workers. Workers may include employees performing beryllium machining, cutting, heat treating, casting, or welding; decontamination of beryllium-contaminated equipment or facilities; maintenance of beryllium-laden plenums or ventilation ducts; quality assurance of purchased beryllium materials; or other beryllium-related job duties.

Employers should ensure that interviews are well organized and systematically conducted. Results must be documented as beryllium inventory information, consistent with the recordkeeping requirements of the rule (see section 4.2.19). Also, interviews should attempt to substantiate beryllium-related information gained from records reviews, as well as address missing information. Employers should solicit the following information during employee interviews to help develop a comprehensive beryllium inventory:

- information to fill gaps that are evident from records review activities,
- undocumented beryllium activities,
- undocumented incidents that involved beryllium or that occurred in areas where beryllium was used,

- work practices and associated controls used to minimize beryllium exposures, and
- facility modifications involving beryllium operations for which as-built drawings do not exist.

4.2.1.3 Sampling and Analysis

Employers must conduct sampling to determine the presence or absence of beryllium materials, surface contamination, or airborne particulates [10 CFR 850(b)(4)]. A sampling and analysis plan may help in organizing and managing the survey. The amount of detail necessary in the plan will depend on the sampling strategy to be used and the size and complexity of the area to be covered. At a minimum, the plan should address the following:

- where samples are to be taken, based on where beryllium was stored, transported, and used at the facility, as well as consideration of ventilation and airflow patterns and worker movement patterns;
- how many samples are to be collected, based on the number of potential exposure locations;
- how the samples will be collected and analyzed, including the air, surface, and bulk sampling methods;
- statistical methods that will be used to ensure confidence and representation of sample results; and
- the personal protective equipment (PPE) and procedures that will be used to protect personnel performing sampling activities.

DOE does not intend for employers to sample locations that are not likely to present a reasonable risk of beryllium exposure based on the inventory. Personnel who conduct the sampling should be acquainted with the building structure and function prior to collecting any samples. These personnel should conduct a building “walk-through” to supplement existing process knowledge and other pertinent information gained from facility record reviews and employee interviews. Personnel involved in a building “walk-through” should be adequately protected against beryllium exposures.

Employers should use knowledge gained from the building “walk-through” and other baseline inventory activities to select sampling areas that provide the greatest potential for harboring residual beryllium materials, contamination, or airborne particulates. Table 4 provides examples of building areas that may have a high potential for beryllium contamination that, if found to be contaminated, may be candidate areas for hazard assessment if the areas are expected to be disturbed.

Sampling activities should include a sufficient number of samples to ensure at least a 95 percent statistical confidence level that the results represent the sample population. Two good references for obtaining techniques for applying statistical principles to sampling are—

- American Industrial Hygiene Association (AIHA) “A Strategy for Assessing and Managing Occupational Exposures,” second edition (ref. 6); and
- National Institute for Occupational Safety and Health (NIOSH) “Occupational Exposure Sampling Strategy Manual” (ref. 7).

Examples of sampling and analysis plans used for hazard assessment at DOE/NNSA sites can be found on the web page for the CBDPP Implementation Tool Kit at—

<http://www.eh.doe.gov/be/itk.html-ssi>

The baseline inventory must include surface, air, and bulk sampling [10 CFR 850.20(b)(4)]. In this Guide, sections 4.2.4, “Exposure Monitoring,” and 4.2.10, “Housekeeping,” address analytical methods for routine sampling and analysis of these media. These analytical methods also should be applied to the baseline inventory.

4.2.1.4 Baseline Inventory Documentation

Employers must document results of the baseline inventory [10 CFR 850.20(a)(3)], so it can be used to support other CBDPP activities. This includes, at a minimum, the following elements:

- historical data on the locations where beryllium was processed, stored, or otherwise present (which should include information obtained from interviewing current employees and retirees);
- a list of areas where beryllium is currently used or stored, and where beryllium was confirmed not to be present;
- a list of areas where beryllium surface or air contamination was found to exist; and
- the quantity and characteristics (chemical form, physical form, and morphology) of the beryllium found.

Table 4. Examples of Potential Beryllium Contamination Areas

Building Area	Potential Area of Be Contamination
Floor	Corner of room where dust accumulates
	Traffic area traversed by beryllium workers
	Area under an object not routinely cleaned
Ceiling Tile	Area adjacent to supply and exhaust ventilation system registers
	Area above beryllium processing area
Process Equipment	Motionless air areas that accumulate dust
	Hidden surfaces not routinely cleaned
Internal Areas	Area behind book shelf
	Area under cabinet drawer
HVAC System	Motionless air areas where dust accumulates
	Area at the top of air ducts
	Access flanges
	Mechanical areas associated with motors and blowers
Miscellaneous Horizontal Surfaces	Door jambs
	Elevated window sills
	Area at the top of light fixtures
	Area at the top of girders or other structural members

4.2.2 Hazard Assessment

Title 10 CFR 850.21(a) requires employers to conduct a beryllium hazard assessment if the baseline inventory establishes the presence of beryllium in an area. This requirement allows each employer the flexibility to determine the appropriate risk-based approach for assessing beryllium-related hazards. Because the CBDPP is designed specifically to prevent CBD in workers, the hazard assessment is the mechanism for determining and documenting the potential exposure of workers to airborne beryllium. The hazard assessment must include analysis of existing conditions, exposure data, medical surveillance trends, and the exposure potential of planned activities [10 CFR 850.21(a)].

Employers should exercise caution in relating previously existing sampling data to current operations and activities because working conditions affecting potential beryllium exposure may have changed. Employers must prioritize exposure determinants and characteristics, as well as

the exposure potential of activities, so they can evaluate activities with the greatest risks of exposure first [10 CFR 850.21(a)].

4.2.2.1 Beryllium Hazard Considerations

CBD is caused by the deposit of respirable beryllium particles in the lung. The degree of hazard is a function of the differing toxicity of the various forms of beryllium and of the type and magnitude of beryllium exposure (see 10 CFR 850 preamble, section I.C.3. for discussion). The chemical form, physical form, and morphology of beryllium are important in determining its toxicity.

Researchers believe that beryllium oxide may be the primary chemical form of beryllium that causes CBD. Particles initially generated as metallic beryllium develop a coating of beryllium oxide because small beryllium metal particles readily oxidize in ambient air. The beryllium oxide coating of respirable-size beryllium metal particles makes up 25 to 30 percent of the particle by weight. Beryl and other ores contain beryllium silicate; mining and milling of these materials has not been associated with disease.

The physical size of the beryllium particle most likely is a key determinant of toxicity because it determines whether the beryllium particle will deposit in the lung. However, the CBDPP action level and PEL, as well as threshold limit values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH) and other exposure limits for beryllium, are based on total airborne beryllium particles. Historically, exposure limits for beryllium have been near the detection limits of sampling and analytical methods so that monitoring only the respirable fraction has not been practical. Investigations are underway to determine whether exposure to respirable beryllium particles is a better indicator of risk than is exposure to total beryllium particles. Employers should, where practicable, characterize the particle size distribution of beryllium particles to which workers are exposed as part of the beryllium hazard assessment. Exposure to the respirable fraction of beryllium particles may prove to better correlate with medical surveillance results than does total beryllium exposure and may be the basis for future standards. Appendix B discusses beryllium particle size and particle number risk factors and provides information about particle size-selective sampling methods. In addition, the following references provide information about size-selective sampling:

- ACGIH monograph, "Particulate Size-Selective Sampling for Air Contaminants," (ref. 8); and
- ACGIH "Air Sampling Instruments for Evaluation of Atmospheric Contaminants," Part I, Section E, "Measurement and Presentation of Aerosol Size Distributions" (ref. 9).

Other determinants of health hazard, in addition to the chemical form, physical form, and morphology of the beryllium, are the likelihood that the beryllium will become airborne and the frequency and magnitude of exposure.

4.2.2.2 Performing Beryllium Hazard Assessments

Title 10 CFR 850.21(b) requires employers to ensure that the hazard assessment is managed by a qualified individual (see section 3 for a discussion of “qualified individual”) and performed by individuals with sufficient knowledge and experience to perform hazard assessments properly. Employers should consider using a multidisciplinary team to perform the beryllium hazard assessment. Actual composition of the team will vary depending on the beryllium hazards present and the specific beryllium activity being assessed, but should include—

- personnel who are knowledgeable of the facility’s support systems (e.g., mechanical, electrical, and physical security);
- operations personnel who are knowledgeable of the facility’s activities;
- environment, safety, and health (ES&H) professionals (e.g., occupational safety, fire protection, emergency management) who are technically qualified to perform hazard assessments and who are familiar with the hazards of beryllium work; and
- workers who are familiar with the facility and who are experienced in beryllium activities.

Clear roles and responsibilities, authorities, and a chain of command should be established and communicated to each team member.

Employers should ensure that the hazard assessment for each beryllium activity takes into account—

- the quantities (actual and potential), chemical and physical forms, and morphology of the beryllium;
- the location of the beryllium;
- the types of events that can lead to beryllium exposures and contamination, including normal activities and potential beryllium emergencies;
- the potential for worker exposure and surface contamination;
- the population of workers that potentially can be exposed and areas that potentially can be contaminated; and
- the anticipated potential levels of exposure and surface contamination resulting from both normal activities and potential beryllium emergencies.

Short-term exposures contribute significantly to individuals’ total doses (see 10 CFR 850 preamble, section I.C.3.) and therefore may be important to assess in order to identify the highest priority activities to control. Employers should also consider other routes of exposure that might not be measured by a breathing zone sample. For example, a worker with beryllium contamination on his or her sleeve could brush the sleeve against his or her nose, resulting in an inhaled dose that would not be captured in a breathing zone sample.

Hazard assessments should also meet requirements, such as those in DOE O 440.1A, paragraph 4(i), and should be integrated with work planning activities to ensure that controls for the potential exposures of planned work tasks (e.g., maintenance, repair, equipment modifications) are addressed in the specific work plans for those tasks.

Title 10 CFR 850.30, in addressing surface contamination, addresses removable surface contamination only. Surface wipes will not detect beryllium that is difficult to remove, sealed beneath paint, or embedded in building materials. Such beryllium, which is not detectable by surface wipes, could potentially become airborne during decontamination and decommissioning (D&D) or remodeling operations. Methods suitable for difficult-to-remove beryllium should be used in addition to surface wipes when identifying potential beryllium hazards for planned demolition, resurfacing, remodeling, or other operations that will significantly disturb structures or building materials. Section 4.2.1 provides guidance on using other sources of information (such as worker interviews and records reviews) to identify locations where beryllium may be present on surfaces from prior beryllium activities.

Rigorous exposure assessment is essential for effective hazard assessment. Exposure assessment should be carried out according to a plan that uses statistical principles to determine meaningful sampling regimens and presentation of sampling results. Results should be presented using statistical tools that also describe the uncertainty, variability, and level of confidence in the results. Employers may select from various statistical tools, which is in keeping with the performance-based nature of 10 CFR 850.30. The rationale for the statistical tools that are used should be included in the CBDPP. Examples of statistical tools used for hazard assessment at DOE/NNSA sites can be found on the web page for the CBDPP Implementation Tool Kit at—

<http://www.eh.doe.gov/be/itk.html-ssi>

Two good references for applying statistical principles to assessing beryllium exposure are—

- AIHA “A Strategy for Assessing and Managing Occupational Exposures” (ref. 6), and
- NIOSH “Occupational Exposure Sampling Strategy Manual” (ref. 7).

Hazard assessments should include a method of identifying and prioritizing beryllium activities with the greatest exposure risk. An example of a simple method for ranking the hazards of beryllium activities based on potential beryllium airborne concentrations is presented in Tables 5 and 6.

Table 5. Hazard Rankings for Known Airborne Beryllium Concentrations

Airborne Be Concentration	< 0.01 $\mu\text{g}/\text{m}^3$	0.01 $\mu\text{g}/\text{m}^3$ to 0.2 $\mu\text{g}/\text{m}^3$	0.2 $\mu\text{g}/\text{m}^3$ to 2.0 $\mu\text{g}/\text{m}^3$	> 2.0 $\mu\text{g}/\text{m}^3$
Level of Hazard	0	1	2	3

Note: Action level is 0.2 $\mu\text{g}/\text{m}^3$. All levels are 8-hour TWA.

Employers in this example must identify and prioritize activities based on the potential for generating dust that contains beryllium. This example is useful in anticipating the levels of airborne beryllium that may be created and may need to be controlled for activities, such as equipment decontamination. Table 5 presents an example of ranking the level of hazard of different levels of airborne beryllium, and Table 6 presents an example of ranking the facility areas based on the magnitude of dust generation.

Table 6. Hazard Ranking Based on Magnitude of Dust Generation

Cleanliness of the Area	Level of Hazard		
	Low Dust Generation	Moderate Dust Generation	High Dust Generation
Assumed Clean	0	0	1
Probably Clean	0	1	2
Possibly Contaminated	1	2	3
Probably Contaminated	2	3	3

Note: The hazard ranking is based on the anticipated level of contamination in buildings. The anticipated level of contamination should be based on the process knowledge review of each building, facility, or area. The cleanliness categories are defined as follows.

- Assumed Clean:
 - areas where beryllium processing was never conducted,
 - air spaces and ventilation systems that are not shared with rooms used for beryllium processing,
 - areas that beryllium workers did not visit unless fully decontaminated, and
 - areas with no other known routes of contamination.
- Probably Clean: areas where beryllium processing was never conducted, but the possibility for cross-contamination from beryllium areas exists through shared air spaces, shared ventilation systems, and cross-contamination by beryllium workers.
- Possibly Contaminated: areas that appear to have a direct connection to a beryllium processing area or where small quantities of beryllium were handled.
- Probably Contaminated: areas where beryllium processing was conducted and the probability for contamination is considered high.

Low dust generation is expected in situations similar to office work or routine passage (e.g., walking) through an area. Moderate dust generation is expected in situations similar to manual work or moving furniture. High dust generation is expected in situations similar to D&D work, machining, aggressive cleaning, or the dismantling of equipment. For example, if the area is assumed to be clean before D&D operations begin and the initial activity will be moving

furniture, the preliminary hazard ranking would be zero, or an expected exposure of less than $0.01 \text{ } \mu\text{g}/\text{m}^3$. However, if the area is assumed to be probably contaminated and most equipment therein will be dismantled, the preliminary hazard ranking is 3, or an expected exposure of greater than $2.0 \text{ } \mu\text{g}/\text{m}^3$. As the actual operations begin, air samples must be taken and analyzed, and the hazard rankings periodically adjusted according to the results.

4.2.3 Exposure Limit and Action Level

Under the requirements of 10 CFR 850.22, employers must ensure that no worker is exposed to an airborne concentration of beryllium greater than the PEL that OSHA established in 29 CFR 1910.1000, Subpart Z, "Toxic and Hazardous Substances," Table Z-2 (ref. 10). OSHA's current PEL is $2.0 \text{ } \mu\text{g}/\text{m}^3$ as an 8-hour time-weighted average (TWA). Title 10 CFR 850.22 will automatically adopt any new PEL that OSHA sets. The exposure is to be measured by a personal monitor in the worker's breathing zone, which is defined as "a hemisphere forward of the shoulders, centered on the mouth and nose, with a radius of 6 to 9 inches." The TWA is the worker's average airborne exposure in any 8-hour work shift of a 40-hour workweek. Employers should use the methods in the OSHA Technical Manual, Section II, Chapter 1, Appendix II:1-6 (ref. 11) to calculate TWAs from sample results for comparison with the PEL. DOE's ORPS, described in DOE O 232.1A, OCCURRENCE REPORTING AND PROCESSING OF OPERATIONS INFORMATION, and detailed in DOE M 232.1-1A, section 9.3, Group 3A, requires the reporting of beryllium exposures to workers that exceed the PEL.

Title 10 CFR 850.23 sets an action level of $0.2 \text{ } \mu\text{g}/\text{m}^3$ as an 8-hour TWA as measured in the breathing zone of the worker by personal monitoring. See Table 3 for CBDPP provisions required at the PEL and the action level.

4.2.4 Exposure Monitoring

Title 10 CFR 850.24 establishes requirements for initial monitoring to characterize potential exposures and requirements for periodic exposure monitoring for workers in areas where airborne concentrations of beryllium are at or above the action level. Exposure monitoring is important for determining the worker exposure levels, the continuing effectiveness of exposure controls, and whether other controls and worker protections are needed.

Only airborne concentrations in the breathing zone are considered for purposes of exposure monitoring. Surface sampling is not appropriate for estimating exposures but is useful for evaluating process control and cleanliness and for determining suitability for release of equipment (see sections 4.2.10 and 4.2.11). Title 10 CFR 850.24 does not address area air monitoring because area air monitoring results cannot be used to represent personal exposure. Area air monitoring may be useful in conjunction with personal air monitoring when characterizing potential worker exposures and when evaluating the effectiveness of process controls. When used for this purpose, area monitors should be placed along the expected path of exposure where the beryllium concentration is expected to be equal to or greater than the worker's potential exposure. Employers should keep in mind the difficulty of anticipating the actual path of exposure when interpreting area air monitoring results. Area air monitoring may

provide information about the source of potential exposures, and it may give additional data about variations in exposure over the course of the work shift.

Breathing zone samples should not be reported as adjusted by protection factors for samples taken while the worker was using respiratory protection. This is the same approach that OSHA uses to demonstrate compliance with OSHA regulations. It permits worker protection professionals to compare and consolidate different sets of breathing zone results. The type of respiratory protection and its protection factor should be noted with the sample results.

Several sources are available for assistance in developing an exposure monitoring strategy (see refs. 6 and 7). Links to additional sources and examples of monitoring strategies and procedures are included on the web page for the CBDPP Implementation Tool Kit at—

<http://www.eh.doe.gov/be/itk.html-ssi>

One common element among the referenced material is the development of a beryllium exposure assessment plan. An effective exposure assessment plan uses statistical principles to determine the most meaningful monitoring regimen and the most meaningful presentation of monitoring results. The exposure assessment plan answers such questions as the following:

- Which employees will be sampled?
- Where will the sampling device be located?
- How many samples will be collected each shift?
- How long will the sampling interval be?
- How many periods during the day should be sampled?
- How many workdays during the year will be sampled?

Such an assessment plan is an important piece of the overall CBDPP, and it is helpful in—

- identifying all potential beryllium exposures;
- ranking exposure hazard potential;
- identifying potentially exposed workers;
- monitoring to characterize exposures;
- documenting, communicating, and keeping records of monitoring results;
- determining the frequency of monitoring; and
- establishing mechanisms to initiate additional monitoring following changes in processes, production levels, materials, controls, work practices, or personnel.

The exposure assessment plan should contain an exposure matrix for all beryllium activities and different forms of beryllium at the facility. Such a matrix is a useful tool for communicating the ranking of exposure potential. Non-routine operations, such as maintenance, repair, cleaning, and D&D, generate some of the highest potential exposures to beryllium.

At the Rocky Flats site, the Beryllium Exposure Assessment Plan includes the following:

- baseline characterization and inventory for affected work areas;
- hazard assessment and risk ranking documentation;
- list of employees or job classifications potentially exposed to beryllium during work activities;
- exposure assessment strategy for characterizing the potential for exposure, including the type of monitoring, the number of workers to be monitored, the frequency and duration of monitoring, and the supporting rationale;
- additional monitoring considerations to address changes in processes, controls, work practices, personnel, and upset or emergency conditions;
- communication of exposure monitoring results to workers and management;
- documentation and recordkeeping requirements; and
- description of sampling and analytical methods.

More details about the Rocky Flats approach, including their related beryllium risk assessment matrix, can be found in the CBDPP Plan document that was prepared in response to DOE N 440.1. That document can be found at—

<http://www.eh.doe.gov/be/Tools.html>

A general requirement of 10 CFR 850.24(a) is that exposure monitoring be managed by a qualified individual (e.g., a CIH) and performed by individuals with sufficient industrial hygiene knowledge and experience.

4.2.4.1 Initial Monitoring

Title 10 CFR 850.24(b) requires employers to perform initial monitoring for all areas that may have airborne beryllium, as indicated by the baseline inventory and hazard assessment. These initial exposure data are necessary for determining compliance with the PEL, exposure level status with respect to the action level, and the extent to which many of the provisions of 10 CFR 850 must and should be implemented. The qualified individual who manages the exposure monitoring, under DOE's performance-based approach, may determine the best monitoring strategy for a particular facility or operation; however, the strategy must be statistically based and must provide enough samples to adequately characterize exposures.

Many employers throughout DOE/NNSA have already conducted initial monitoring as part of their implementation of the CBDPP required by DOE N 440.1. Therefore, employers can use initial monitoring data collected within 12 months prior to the effective date of 10 CFR 850 to satisfy the initial monitoring requirement. Such previous results would only be valid, however, if conditions affecting the beryllium have not changed.

The details of the initial exposure monitoring approach are left to the discretion of the employer and the qualified individual who manages the exposure monitoring. An acceptable approach would include the following.

- All operations and job tasks should be characterized for both full shift and potential peak exposures.
- New operations, or those recently modified or previously uncharacterized, will likely require the most intensive initial exposure evaluation.
- Personal monitoring and sample analysis should be conducted in accordance with procedures in the OSHA Technical Manual (ref. 11) and NIOSH methods 7102 and 7300 (refs. 12 and 13) or equivalent. Employers should document the equivalency of methods used other than those in refs. 11-13.
- Initial monitoring should include short-term breathing zone samples for operations where it reasonably can be expected that brief, high concentrations of beryllium may be possible. Such samples should be taken during periods expected to produce the highest exposure levels.

4.2.4.2 Periodic and Additional Monitoring

Title 10 CFR 850.24(c) requires periodic exposure monitoring of workers who work in areas where airborne beryllium concentrations are at or above the action level ($0.2 \mu\text{g}/\text{m}^3$). The monitoring must be conducted in a manner and at a frequency necessary to represent workers' exposure. In addition, this periodic exposure monitoring must be performed at least quarterly. These requirements leave plenty of flexibility for employers to determine the monitoring frequency best suited for accurately characterizing workers' exposures.

Employers should take a risk-based (graded) approach to determining the frequency of monitoring in accordance with the baseline and subsequent hazard assessments. A minimum frequency of 3 months is required because slight process or procedural changes may go unnoticed over time and because facility and equipment deterioration can affect exposure levels. Employers must also perform additional monitoring and should update exposure assessment plans whenever operations, maintenance, or procedures change and whenever they have reason to suspect that changes may result in new or additional exposures [10 CFR 850.24(d)]. Exposure assessment plans should be updated annually.

The employer's exposure monitoring plan may specify the use of representative monitoring. If so, careful planning is needed to ensure that the results truly represent all potential exposures. Groups chosen for representative monitoring should be identified based on actual tasks performed and the individuals' exposure histories. Job title and other administrative groupings usually are not indicators of exposure and should not be used to identify representative monitoring groups. Employers should monitor individuals with the highest expected exposure in a given representative group. Employers can make better decisions about the number of individuals to be monitored as more monitoring is conducted and more operational experience is gained.

DOE G 440.1-3, OCCUPATIONAL EXPOSURE ASSESSMENT (ref. 14), and AIHA's "A Strategy for Assessing and Managing Occupational Exposures" (ref. 6) contain in-depth discussions of using similarly exposed groups (SEG) to represent exposures. A SEG is a group of individuals who perform the same jobs or tasks and who have similar potentials for exposure to hazardous agents (e.g., beryllium). Once a SEG is established, employers may monitor the exposures of selected workers in the group to predict the exposures of the remaining workers. A sufficient number of individuals should be monitored to establish a statistically valid exposure profile within the SEG.

The frequency of personal air monitoring should vary with the expected level of beryllium exposure. Statistically based monitoring is necessary to validate decisions about increasing or reducing the monitoring frequency including terminating monitoring. Monitoring frequency may be reduced where repeated, statistically valid, monitoring results demonstrate that exposure levels emanating from processes and controls have stabilized at exposure levels below the action level. Monitoring may be terminated if exposure levels are consistently, sufficiently low. Employers may conduct monitoring more frequently than the expected level of exposure warrants. An occasional increase in sampling frequency can foster lower exposures by providing performance measures that motivate workers to actively trend and reduce their own exposures. Employers may better validate their CBDPP through the use of frequent personal monitoring. Additional reasons for frequent personal air monitoring include—

- greater assurance that workers are not overexposed,
- better characterization of variable exposures in the workplace,
- more effective identification of ways in which individual work practices contribute to high exposures, and
- more frequent feedback on the efficacy of workplace controls.

The added value of frequent monitoring should be considered when developing an exposure assessment plan. The cost of frequent monitoring can be relatively small compared with that of a worker overexposure or the shutdown of an operation because gradual degradation in performance of the exposure control system went unnoticed.

The rule requires employers to apply statistically based monitoring strategies to obtain a sufficient number of sample results to adequately characterize exposures, before reducing or terminating monitoring [10 CFR 850.24(b)]. An exposure assessment plan that uses statistical principles to determine the most meaningful monitoring regimen and presentation of monitoring results is most likely to adequately characterize exposures.

Exposure monitoring is not required in areas where airborne beryllium concentrations are below the action level. However, monitoring is one of the tools available for exposure reduction and minimization, even at low exposure levels (see section 4.2.5).

Non-routine operations, such as maintenance, repair, cleaning, or D&D operations in the presence of beryllium contamination, have a significant potential for beryllium exposure. Employers should monitor every worker for every shift for non-routine operations, but less

monitoring may be appropriate under limited circumstances. Both representative monitoring and reduced frequency of monitoring for specific operations may be appropriate once the operations and their controls are stable, and statistically valid monitoring data demonstrate that exposure levels are stable and consistently below the action level. D&D operations tend to be highly variable, so attaining consistently stable D&D operations and controls can be rare. Personal air monitoring must be conducted at least daily for each task or work group to confirm that the level of respiratory protection is adequate wherever respirators are used.

Employers may decide to have workers do a limited amount of self-sampling. Having workers “hang their own pumps” can be cost-efficient and can free up industrial hygiene technicians for other tasks. However, a qualified individual must ensure that sampling is performed properly and should not rely on workers to maintain adequate notes about worksite conditions and potential confounders of the results. Trained technicians should calibrate the pumps and prepare the sample media. Workers should be adequately trained to operate their own pumps, and the sampling protocol should be reviewed periodically.

Employers performing statistical analysis of personal monitoring data for consistently stable and well-controlled beryllium activities often will find that their exposure data are more variable than typical occupational exposure data. High variability in exposure data normally is associated with lack of control of exposures from an activity, but the opposite is true for these well-controlled activities. DOE’s typical employers have monitored beryllium exposures at a high frequency and eliminated the predictable exposures. Most of the monitoring data are below the level of detection and only the less-predictable exposures remain from these activities. These data sets, consisting of large numbers of non-detectable results and a small number of measurable excursions, exhibit a high statistical variability but represent a well-controlled activity. The excursions result from the remaining equipment failures and human errors that can occur even with a well-controlled activity. Employers should recognize that these excursions can present significant health risks due to beryllium’s high toxicity and should target such excursions for exposure reduction and minimization efforts.

An acceptable alternative to using representative monitoring to describe beryllium exposure profiles is to use 100 percent monitoring for all potentially exposed workers. The Atomic Weapons Establishment (AWE) facility in Cardiff, Wales, monitored every beryllium worker during every shift for the nearly 40 years that it was in operation.

Appendix C contains further guidance on statistical analysis of beryllium monitoring results, including examples that use actual beryllium monitoring data obtained at DOE/NNSA facilities.

4.2.4.3 Accuracy and Analysis

Title 10 CFR 850.24(e) requires employers to use a method of monitoring and analysis that is accurate to within plus or minus 25 percent, with a confidence level of 95 percent, for airborne concentrations of beryllium at the action level. This degree of accuracy is needed to ensure that exposure monitoring results are sufficiently accurate across the relevant range of exposure levels.

Title 10 CFR 850.24(f) requires employers to have exposure monitoring samples analyzed in a laboratory accredited for metals analysis by the AIHA or by a laboratory that demonstrates quality assurance for metals analysis that is equivalent to AIHA accreditation. Equivalency to AIHA's accreditation means that a laboratory can demonstrate that its testing protocols meet the accreditation standards of AIHA. These accuracy and quality requirements are consistent with similar requirements that appear in many of OSHA's expanded health standards for toxic substances.

The AIHA laboratory accreditation program includes metals that are common in industrial hygiene samples. Beryllium currently is not one of those metals. Employers may require laboratories that wish to analyze beryllium samples to demonstrate successful participation in the Beryllium Round Robin Program administered by the Y-12 Analytical Services Organization. This program for beryllium is equivalent to the AIHA accreditation program for metals.² Employers wishing to obtain additional assurance of an AIHA-accredited laboratory's quality assurance specifically for beryllium samples can include blind samples (samples of known concentration prepared by the employer) with actual samples. Employers may wish to provide the laboratory with a bulk quantity of the beryllium material being sampled so that the laboratory can prepare quality control samples. Also, laboratories can use the bulk quantity of the beryllium material to investigate the percentage of beryllium in the samples that is reported in the analytic results. This is particularly important for beryllium materials (e.g., beryllium oxide) that are difficult to get into solution using the published standard analytic methods.

Title 10 CFR 850.24(f) does not specify the sampling and analysis procedures to be used for beryllium. Employers should use NIOSH Analytical Method 7102 (ref. 12), NIOSH Analytical Method 7300 (ref. 13), OSHA Technical Center Analytical Method ID-125G (ref. 15), or equivalent method. For example, an acceptable approach would be that used at Lawrence Livermore National Laboratory (LLNL) for analysis of air samples. LLNL uses a modification of NIOSH Method 7300 for beryllium metal, and a LLNL-developed procedure (employing inductively coupled plasma atomic emission spectroscopy) for high-fired beryllium oxide. The modified NIOSH procedure for beryllium metal uses nitric acid only as the ashing agent (rather than the nitric/perchloric acid mixture recommended in 7300). Similarly, the LLNL method for high-fired beryllium oxide uses a nitric/sulfuric acid mixture, rather than the NIOSH-recommended mixture, to achieve complete dissolution. For air samples where only one metal is to be analyzed, sample filters are dissolved to make 10 ml of solution. Samples are dissolved to make 25 ml of solution for air samples where more than one metal is to be analyzed. Any modifications to NIOSH procedures and locally developed analysis techniques must be appropriately validated. AIHA defines validation as the process of sustaining specified performance criteria (ref. 16) and describes method validation procedures in their Quality Assurance Manual for Industrial Hygiene Chemistry (ref. 17). AIHA's description of method validation procedures is written for solvents, however, so employers should modify the procedures as appropriate for beryllium and document those procedures. The Quality Assurance Manual for Industrial Hygiene Chemistry (ref. 17) also describes method documentation.

²DOE and AIHA at this time are discussing including beryllium as one of the metals in the AIHA accreditation program. The Y-12 Beryllium Round Robin Program may be discontinued if and when AIHA includes beryllium.

Employers may use rapid analysis of worker exposure samples as a means of reducing exposures by quickly identifying and controlling unexpected sources. The AWE facility in Cardiff, Wales, successfully used that approach for many years. AWE analyzed samples at the end of each shift, analyzed samples from its most common sources of high exposures during the lunch break, and corrected the problems identified by unexpectedly high exposure levels before continuing to operate.

Title 10 CFR 850 has no requirement for particle size sampling, but employers should, where practicable, characterize the particle size distribution of beryllium particles to which workers are being exposed. Section 4.2.2.1 provides the rationale for particle size sampling.

4.2.4.4 Notification of Monitoring Results

Title 10 CFR 850.24(g)(1) requires employers to notify affected workers of monitoring results in writing within 10 working days after receipt of the results. Employers can notify the workers personally, or they can post the results in a location that is readily accessible to the affected workers but in a manner that does not identify individual workers to other workers. Notifying affected workers by e-mail is acceptable as long as employers can document that workers have read the e-mail and that the employer has not identified individual workers to others. The protection of workers' privacy is consistent with OSHA's substance-specific standards that have posting requirements.

Sampling results should include the actual airborne concentrations of beryllium and the sampling time used for calculation, along with any calculated TWAs. Results provided to the monitored workers should include both unadjusted results and results adjusted by respiratory protection factors, along with an explanation of the meaning of the results.

Title 10 CFR 850.24(g) contains additional requirements for notification when the worker's exposure meets or exceeds the action level. In such cases, the worker notification must include—

- a statement that the action level has been met or exceeded, and
- a description of the corrective action being taken by the employer to reduce the exposure to below the action level.

In such cases, employers also must notify DOE/NNSA and the Site Occupational Medical Director (SOMD) within 10 days of receipt of the results [10 CFR 850.24(g)(3)]. Notifying the SOMD allows the SOMD to be proactive in refining the medical surveillance protocol for affected workers to ensure effective monitoring and early detection of beryllium-related health effects.

4.2.5 Exposure Reduction and Minimization

The objectives of exposure reduction and minimization must be to reduce the number of workers currently exposed to airborne beryllium in the course of their work at DOE/NNSA facilities and minimize their potential for, and actual, exposure to airborne beryllium. Title 10 CFR 850.25 uses a graded approach to exposure reduction and minimization based on the level of beryllium hazard. Employers must—

- ensure that exposures are below the PEL;
- implement a formal program to reduce exposure levels to below the action level, if practicable; and
- continue to reduce and minimize exposures, if practicable, where exposures are below the action level.

Less formality is acceptable to reduce and minimize exposures that are below (as opposed to above) the action level.

Employers should consider social, technical, economic, practical, and public policy considerations in developing a rationale for exposure reduction and minimization appropriate for their facilities. Each employer has broad discretion in selecting control options and should apply a graded approach to minimizing beryllium exposures based on the level of risk of incurring CBD. Employers must document the rationale in their CBDPPs.

A rationale for selecting reduction and minimization measures that do not reduce exposure levels to below the action level, or that do not continue to reduce exposure levels that are below the action level, should explain why those desired reductions cannot practicably be obtained. Also, the rationale should describe the level of protection that will be provided by the practicable measures that were selected.

4.2.5.1 Graded Exposure Reduction and Minimization Programs

Title 10 CFR 850.25 establishes requirements for reducing and minimizing worker exposures to airborne beryllium. Where exposures are above the action level, section 850.25(b)(1) requires employers to include in their CBDPPs a formal program to reduce exposures to below the action level, if practicable. The program must include—

- annual goals for exposure reduction and minimization,
- a rationale and strategy for meeting the goals,
- actions that will be taken to achieve the goals, and
- a means of tracking progress towards meeting the goals or demonstrating that the goals have been met.

Goals for exposure reduction and minimization should be established and reestablished periodically using a risk-based approach. Reestablishing goals does not require a continuous reduction in exposures, but instead ensures that goals are current with facility missions, and that the employer is actively engaged in implementing and continuously improving the CBDPP. In some cases, goals may be modified to allow higher exposures consistent with mission changes requiring increased workloads or activities that emit greater amounts of airborne beryllium so long as these goals never exceed the PEL. For sites conducting extensive non-routine activities, such as D&D, goals reflecting the intrinsically higher level of risk and limited availability of engineering controls may be appropriate. When establishing exposure reduction and minimization goals, the following factors should be considered:

- existing exposure levels;
- reductions in exposures needed to reach the PEL or action level;
- impact on workers;
- effectiveness of control options;
- impact on operations; and
- social, technical, economic, practical, and public policy considerations in determining the practicability of various control options for reducing and minimizing worker exposure to beryllium.

Section 850.25(b)(2) requires employers to take steps to reduce and minimize exposure to the extent practicable, even if exposures are below the action level. Those steps and the rationale supporting them must be described in the facility's CBDPP. The level of detail and rigor involved in procedures for exposure reduction and minimization may be lower for exposure levels that are below the action level than for exposures that are above the action level.

Employers' goals to reduce and minimize exposure should represent practicable measures. It may be appropriate to establish goals for minimizing exposure levels of groups of workers, minimizing exposure levels of individual workers, and reducing the total number of exposed workers. For example, new facilities offer the opportunity to include cost-effective engineering controls to minimize routine exposures to groups of workers. Careful observation of work practices offers the opportunity for minimizing individual exposures. Changing the location of beryllium activities and worker movement patterns offers the opportunity for reducing the number of potentially exposed workers in facilities where modifying the facility is not a viable option.

Goals reflecting exposure reduction and minimization efforts may include the following.

- No more than (a specified) percent of all measured exposures for (a specified) time period will exceed the PEL, action level, detection limit.
- There will be (a specified) percent reduction of incidents of uncontrolled exposures during (a specified) time period.

- The total number of beryllium workers will decrease by (a specified) percent during (a specified) time period.
- The number of beryllium hazard assessments completed per month will increase by (a specified) percent during (a specified) time period.
- The number of beryllium-associated workers participating in scheduled medical surveillance per month will increase by (a specified) percent during (a specified) time period.
- The number of beryllium-associated workers completing scheduled beryllium hazard communication training per month will increase by (a specified) percent during (a specified) time period.

Goals should be normalized to reflect mission changes that increase, as well as decrease, the potential for beryllium exposure.

Additional information specific to exposure reduction and minimization goals and performance measures is provided in section 4.2.20. Additional general information on goals can be found in DOE's Training Resources and Data Exchange (TRADE) organization's "How To Measure Performance: A Handbook of Techniques and Tools" (ref. 18).

A multidisciplinary team, managed by a qualified individual (e.g., an industrial hygienist), should review the beryllium activities, exposure levels, and controls to determine appropriate actions for reducing and minimizing exposures. The team should include line management, workers, maintenance, and worker protection personnel, as well as other support personnel familiar with beryllium operations, hazards, and control methods. A typical review may include, but is not limited to, the following:

- an evaluation of the general configuration of the facility and impacts of different possible beryllium control strategies on operations including traffic patterns; location of beryllium sources; need for change rooms; number of beryllium-associated workers; decontamination facilities needed; personal monitoring needed; level of training needed; level of physical security needed; adequacy of space for proposed modifications; and the impact on maintenance, production, research, and D&D activities;
- verification that the design criteria for beryllium activity operations and controls are consistent with reduction and minimization goals and any applicable regulations or local requirements;
- verification that beryllium controls provide the required level of protection from airborne beryllium;
- evaluation and confirmation of the adequacy of specific control methods for reducing the opportunity for worker exposures including control of procurement, storage, and transportation of beryllium; local exhaust ventilation systems; and operational area containment systems;

- verification that the facility design is able to maintain personnel entry control for each regulated area to prevent the spread of contamination, and that the design is commensurate with the existing or potential beryllium hazard within the regulated area;
- assessment of the adequacy of the monitoring planned for activities and spaces that involve potential beryllium exposure to characterize worker exposures and surface contamination, provide measurements needed to implement the reduction and minimization control strategies, and identify elevated or unplanned beryllium exposures.

Work planning efforts should incorporate exposure reduction and minimization strategies to ensure that appropriate control strategies are selected for activities that are managed by work planning systems. Fundamental principles of enhanced work planning or a similar collaborative planning process should be followed to ensure that appropriate control strategies are selected for the planned activities. At the completion of short-term beryllium activities such as maintenance, post-job reviews should be conducted to identify lessons learned and best practices to control beryllium exposures during future work. Such reviews are in line with DOE's ISM expectations. One of the core functions of ISM is to provide feedback for improvement of work operations.

Links to additional sources and examples of control strategies are included on the web page for the CBDPP Implementation Tool Kit at—

<http://www.eh.doe.gov/be/itk.html-ssi>

4.2.5.2 Hierarchy of Controls

Title 10 CFR 850.25(c) mandates using the conventional hierarchy of industrial hygiene controls: material substitution and engineering controls must be accomplished first if practicable, followed by administrative and work practice controls, followed by PPE. (PPE is addressed in sections 4.2.8 and 4.2.9 of this Guide.)

Engineering Controls

Primary reliance must be placed on engineering controls for maintaining airborne concentrations as low as practicable. Engineering controls normally include local exhaust ventilation, gloveboxes, and other enclosures. For non-routine operations, temporary enclosures such as glovebags or negative-pressure enclosures (NPEs) can be used to control exposures and contamination. Engineering controls also include wet methods for cutting, grinding, machining, sanding, or processing solid beryllium. Caution still should be exercised since any airborne contaminated liquid generated is a potential source of exposure.

Ventilation

Employers should ensure the proper design, construction, and maintainability of ventilation systems used to control emissions from beryllium activities. Employers should ensure that these systems adequately control beryllium emissions and minimize the exposure potential of workers who test, service, and repair the system.

Hood configuration and airflow rates are critical design features for adequate face or capture velocity. Insufficient face velocity and excessive air turbulence allow toxic materials to remain airborne around the hood and could be drawn into the breathing zones of workers. Hood designs should be specific for the actual operation. Exhaust from routine beryllium-processing operations that could produce airborne particulates should be vented to the environment through an approved high-efficiency particulate air (HEPA) filter. Make-up air must be supplied where air is removed from an area. Make-up air systems should be constructed so they do not draw in contaminated exhaust air, create turbulence that disperses beryllium contamination, or contaminate the workspace with toxic or irritating materials originating from some other location.

Employers should ensure that the design, construction, and maintenance of ventilation control systems for beryllium activities conform to a standard such as American National Standards Institute/American Society for Mechanical Engineers (ANSI/ASME) AG-1 “Code on Nuclear Air and Gas Treatment.” These systems contain HEPA filters, which should conform to both section FC (HEPA Filters) of AG-1 and DOE-STD 3020-97, “DOE Standard Specification For HEPA Filters Used by DOE Contractors.” Employers should use section 6 (Quality Assurance) and section 7 (Packaging, Shipping, and Storage) of DOE-STD 3020-97 if applying only the AG-1 standard because AG-1 does not cover these subjects.

ACGIH “Industrial Ventilation: A Manual for Recommended Practice” (ref. 19) also contains recommendations for design and airflow specifications of local ventilation systems. Section 10.40 (Low-Volume/High-Velocity Exhaust Systems) of the ACGIH manual includes applications for beryllium operations. Employers may obtain even better control of airborne beryllium by using state-of-the-art ventilation systems such as the High-Volume/High-Velocity Exhaust System and other systems that Los Alamos National Laboratory (LANL) is using in its new beryllium facility. The LANL system is described in the “Beryllium Technology Facility Auditable Safety Analysis,” which can be found at—

<http://www.eh.doe.gov/be/itk.html-ssi>

Engineering controls should also be checked after any change in work operations or equipment that might affect the controls to ensure that changes do not impair or overwhelm the system’s efficacy and that all design specifications continue to be met. Normal beryllium operations should not be resumed until the system is shown to be operating properly.

Ventilation systems should be evaluated periodically under actual operating conditions to ensure continued operation at design specifications. To show that ventilation systems are operating properly, visual indicators, audible alarms, telltale power lights, or flow indicators should be installed at appropriate workstations in work areas that routinely process beryllium. Workers should perform operational checks of their engineering controls before beginning work. These initial tests ensure that the systems are on and that air is circulating through them. Ventilation systems also should be scheduled for preventive maintenance.

Glove Bags and Negative Pressure Enclosures

Temporary enclosures provide an adequate approach to controlling exposures and contamination for non-routine operations, such as maintenance or D&D activities. Responsible employers should use temporary enclosures to keep exposures as low as practicable because exposure levels may be difficult to predict for non-routine activities. Glovebags provide a flexible, easily installed, and quickly removed temporary work enclosure ideal for small-scale maintenance or D&D activities. When installed and used properly, they permit workers to remain completely isolated from beryllium dust. Glovebags installed with support frames also can be used as NPEs when connected to a HEPA-filtered vacuum system. Additional information about glovebags can be found in 29 CFR 1926.1101 (ref. 20). That standard is concerned with controlling exposures to asbestos, but much of the information provided is directly applicable to controlling exposures to beryllium dust.

NPEs may be an appropriate control method for preventing contamination outside the enclosure for larger-scale maintenance and D&D activities. This control method does not necessarily reduce exposures of workers within the NPE. Exposures can be minimized within the enclosure, however, by directing air movement away from the workers and toward a HEPA filtration system. NPEs usually are constructed of 6-mil plastic and maintained under a negative pressure of at least 0.02 inch of water pressure differential, relative to outside pressure. Additional information on NPEs can be found in 29 CFR 1926.1101 (ref. 20).

Administrative Controls

Administrative controls can be an effective means for reducing and minimizing worker exposures. The degree of formality and scope of the administrative controls should be commensurate with the beryllium hazards encountered and the complexity of the associated control measures. More rigorous administrative processes should be implemented for more complex or hazardous activities. Administrative controls should include a hierarchy of documents that clearly delineate management policies, requirements, expectations, and objectives for the CBDPP. The documentation typically includes—

- a policy statement that describes the employer's high priority for health and safety and the expectation that administrative controls will be followed regardless of budget or schedule pressures;
- facility-specific procedures that delineate responsibilities and the actions required; and
- detailed instructions for implementing various functional elements of the CBDPP.

Written procedures should be developed and implemented as necessary to ensure compliance with 10 CFR 850, commensurate with the beryllium hazards and consistent with the education, training, and skills of the beryllium workers. Written procedures should be employed under the following circumstances:

- when worker health and safety are directly affected;

- when the expected outcome for the process or operations requires that a specific method be followed;
- when the process or operation is infrequently used and competence training cannot ensure adequate implementation; and
- to document the approved method to implement specific processes or operations.

Administrative controls involve changing work conditions or operations to lower exposure. Examples of appropriate administrative controls include—

- scheduling maintenance activities that generate airborne beryllium during times when most workers are elsewhere;
- arranging operations, schedules, or equipment such that fewer persons are potentially exposed or persons are exposed for shorter periods or to lower concentrations of beryllium;
- developing location-specific exposure reduction and minimization procedures; and
- posting warning signs (see section 4.2.18).

Administrative control through worker rotation is not recommended because this practice does not reduce the number of workers exposed to beryllium. At the Rocky Flats site, only a limited subset of workers in each trade discipline is used to perform work in beryllium areas. In addition, operations should be as efficient as possible to minimize unnecessary steps and reduce the length of time spent on beryllium operations.

Tours and visitors should not be permitted in areas with the potential for beryllium exposure. Instead, alternative methods of viewing the activities and processes, such as closed-circuit television, videotapes, or adjacent viewing rooms with windows, should be used.

Location-specific industrial hygiene procedures are another example of an administrative control for protecting workers from the hazards of beryllium. All beryllium processes and activities capable of generating airborne beryllium should have a location-specific industrial hygiene procedure to address the hazards and identify appropriate controls. Examples of such processes are cutting, machining, welding, maintenance, and D&D activities. For non-routine work, a qualified individual (e.g., an industrial hygienist familiar with beryllium controls) should participate in the planning phase and review all work control documents to ensure reduction and minimization goals are addressed.

4.2.6 Regulated Areas

Title 10 CFR 850.26(a) requires employers to establish regulated areas where airborne concentrations of beryllium are measured at or above the action level. Responsible employers may establish regulated areas for any location with the potential for airborne beryllium at or above the action level or the potential for spreading beryllium contamination. Regulated areas are established to limit the number of individuals exposed and potentially exposed, to provide formality of operations for persons who enter the location, and to limit the spread of contamination to uncontrolled areas. At the Pantex facility, beryllium work permits have been used for procedure control of all beryllium-regulated areas. The permits, signed by the Industrial Hygiene Department, specify work practices, controls, training, and respirators and PPE. Visitors are not permitted in beryllium-regulated areas unless absolutely necessary; visitors who enter must complete beryllium awareness training, be escorted, wear appropriate respirators and PPE, and comply with procedures.

Title 10 CFR 850.26(b) requires employers to demarcate regulated areas from the rest of the workplace to adequately alert workers to its boundaries. This would include the use of physical barriers and signs. Operations and activities with beryllium exposures vary throughout the complex (as well as at individual facilities), so a single type of regulated area would not suit all possible situations. Regulated areas may vary from a simple barricade around a designated area with a small zone for decontamination to a facility supported by permanent contiguous hygiene facilities. A qualified individual (e.g., an industrial hygienist) should play a major role in determining whether an area needs to be classified as a regulated area.

Paragraphs (c) and (d) of 10 CFR 850.26 mandate employers to limit access to regulated areas to authorized persons and to keep records of all individuals who enter the area. Employers must evaluate the affected operation and determine which personnel are necessary for the performance of work and thus are candidates for authorization to enter. Entry records must include the name, date, time in, time out, and work activity [10 CFR 850.26(d)]. Such a record ensures that employers are knowledgeable about all persons who work in a regulated area and, in addition, helps to relate any health events to possible exposures. Access records are particularly important when exposure-monitoring results indicate that an unforeseen elevated exposure has occurred. DOE intends that only individuals essential to the performance of work in the regulated area will be authorized to enter the area.

The controls necessary for a regulated area vary to reflect the actual or potential level of airborne concentration or surface contamination. There should be storage outside the area for clean PPE. A contamination reduction zone should be established with containers for booties, outer garments, respirators, and other equipment. Temporary regulated areas may sometimes be needed for maintenance, intermittent operations, or unforeseen situations. Procedures and devices similar to those used for asbestos removal (ref. 20) should be used (including the use of polyethylene enclosures with three-chamber decontamination units) for operations that could generate visible amounts of beryllium-containing dust. For permanent activities where the action level is likely to be exceeded, regulated areas should be wholly separate rooms maintained at a negative pressure with respect to adjacent areas to minimize the migration of contamination.

All potential sources of contamination should be identified to ensure the integrity of the regulated area when persons and items move in and out of the area. For example, it may be appropriate to assume that papers inside the regulated area are contaminated. For this reason, the AWE at Cardiff photocopied all papers on a machine at the area barrier. The copies came out of the clean side of the barrier, and the originals were retained in the beryllium area until disposed of as beryllium waste.

4.2.7 Hygiene Facilities and Practices

4.2.7.1 General Practices

Title 10 CFR 850.27(a)(1) and (2) prohibit the use of food, beverages, and tobacco products and the application of cosmetics in areas where exposures are at or above the action level. Responsible employers also may prohibit these items in areas with even the potential for airborne beryllium levels at or above the action level. Procedures should establish specific acceptable areas for eating, drinking, smoking, and applying cosmetics. See section 4.2.7.4 for information about lunchroom facilities. Title 10 CFR 850.27(a)(3) requires that beryllium workers be prevented from exiting areas that contain beryllium with contamination on their bodies or their personal clothing. Employers must provide the means to decontaminate workers at a boundary of these areas to meet this requirement. Decontamination may vary from simply removing protective clothing outer garments at the barricade to following a multi-step procedure in a full decontamination facility (e.g., contiguous rooms separated by doors, negative pressure zones, contamination reduction zones, and showers) depending on the assessment of the beryllium hazard.

4.2.7.2 Change Rooms or Areas

Title 10 CFR 850.27(b)(1) requires employers to provide clean change rooms or change areas for beryllium workers who work in regulated areas. Separate facilities free of beryllium must be provided where beryllium workers can change into and out of personal clothing and into clean protective clothing and where they can store clothing and equipment. These facilities are necessary to prevent cross-contamination between work and personal clothing and the subsequent spread of beryllium into clean areas of the facility and into workers' private automobiles and homes, and ensure that workers do not change into protective clothing that already is contaminated and will contribute to their exposure.

Title 10 CFR 850.27(b)(2) requires employers to provide change rooms or areas for removing beryllium-contaminated clothing and equipment. These change rooms or areas must be maintained at negative pressure or located to prevent the spread of beryllium into clean areas.

4.2.7.3 Showers and Handwashing Facilities

Title 10 CFR 850.27(c) requires employers to provide handwashing and shower facilities for beryllium workers who work in regulated areas. Workers are required to shower at the end of a work shift.

4.2.7.4 Lunchroom Facilities

Title 10 CFR 850.27(d)(1) establishes requirements to ensure that workers are not exposed to beryllium at or above the action level while eating in lunchroom facilities. Employers must provide lunchroom facilities that are readily accessible to beryllium workers and ensure that the tables for eating are free of beryllium surface contamination.

Title 10 CFR 850.27(d)(2) prohibits beryllium workers from entering lunchroom facilities with protective equipment or work clothing containing surface beryllium. Surface beryllium must first be removed from clothing and equipment by using a HEPA vacuum (see section 4.2.10 of this Guide) or some other method that removes the beryllium without dispersing it.

4.2.7.5 Sanitation

Change rooms or areas, shower and handwashing facilities, and lunchroom facilities must meet the sanitation requirements of 29 CFR 1910.141.

4.2.7.6 Location of Hygiene Facilities

The location of hygiene facilities and proximity of these facilities to regulated areas may vary based upon the assessment of the beryllium hazard. Decontamination of workers and equipment leaving a regulated area must be accomplished at a border of the area, but 10 CFR 850 does not require that hygiene facilities be contiguous to the area. It is often impractical to have hygiene facilities adjacent to operations when operations are changing, are of short-term duration, or are small scale and low hazard. Conversely, employers should provide hygiene facilities contiguous to regulated areas for high beryllium hazard operations.

An effective configuration for contiguous hygiene facilities is to have the area used for changing into clean protective clothing separated by a walk-through shower from the area used for removing beryllium-contaminated clothing, and have the lunchroom adjacent to the regulated area at the border where decontamination is accomplished. (The border where decontamination is accomplished may also be the area used for removing beryllium-contaminated clothing.) This arrangement provides a great deal of flexibility for tailoring entry and exit procedures to address varying beryllium hazards.

Entry and exit procedures for hygiene facilities should be technically sound, clearly expressed, and consistently followed to minimize cross-contamination of protective clothing and equipment and dispersion of beryllium contamination into clean areas. This is particularly important for hygiene facilities that are not adjacent to operations since workers and equipment may move through clean areas before handwashing, showering, and removing personal protective clothing that may not have been thoroughly decontaminated when the worker exited a regulated area.

4.2.8 Respiratory Protection

Title 10 CFR 850.28 establishes respiratory protection requirements for the CBDPP. Paragraph (a) requires employers to establish a respiratory protection program that complies with OSHA

standard, 29 CFR 1910.134 (ref. 21). Paragraphs (b) through (d) contain supplemental requirements that deal specifically with respiratory protection from airborne beryllium.

The respiratory protection provisions in 10 CFR 850.28 differ in several ways from those in DOE N 440.1. This includes requirements for the use of respiratory protection—

- at the action level rather than at the OSHA PEL,
- based on task analysis in addition to measured airborne levels, and
- when requested by beryllium-associated workers, regardless of exposure.

Respiratory protection programs are required when employers have implemented all practicable engineering and administrative controls and the action level still is exceeded. Employers may also use respiratory protection as part of their exposure reduction and minimization programs to further reduce exposures to the lowest level practicable. OSHA standard, 29 CFR 1910.134 (ref. 21), contains the minimum requirements for a complete respiratory protection program. Employers may elect to use more stringent requirements.

Title 10 CFR 850.28(b) requires employers to provide respirators to all workers exposed at or above the action level and all workers performing tasks for which analyses indicate the potential for exposures at or above the action level. In addition, employers must ensure that workers use the respirators. Employers are also required to include in the respiratory protection program any beryllium-associated worker who requests a respirator for protection against airborne beryllium, regardless of measured exposure levels [10 CFR 850.28(c)]. This includes providing respirators (at no cost) to beryllium-associated workers who request them.

The reason for providing respiratory protection based on task analyses is that many tasks that normally have no measurable exposure level may result in high concentrations of airborne beryllium due to a procedural error, worker error, or equipment failure.

Title 10 CFR 850.28(d) requires employers to select NIOSH-approved respirators when NIOSH-approved respirators exist for the DOE task. Employers must select respirators that DOE has accepted under the DOE/LANL Respiratory Protection Acceptance Program when NIOSH-approved respirators do not exist for the particular DOE/NNSA task.

Additional information on respiratory protection can be obtained from—

- ANSI standard Z88.2, “Practices for Respiratory Protection” (ref. 22); and
- AIHA manual, “Respiratory Protection: A Manual and Guideline” (ref. 23).

ANSI Z88.2 lists assigned protection factors for various respirators. However, on January 8, 1998, OSHA promulgated a revised version of 29 CFR 1910.134. In revised 29 CFR 1910.134, OSHA reserved section 29 CFR 1910.134(d)(3)(i)(A) for assignment of protection factors. The new factors will reflect changes in respiratory protection technology and may supercede those in

the ANSI Z88.2 table. CBDPPs should be updated to reflect these changes once the new factors are published.

The actual protection offered by respirators may vary for individuals depending on the fit of the respirator and the conditions of use. Respirators accepted for use at higher concentrations may be used at lower concentrations. Respirators must not, however, be used at concentrations higher than those for which they are approved. Full-face-piece respirators should be worn during operations where airborne, soluble forms of beryllium may irritate the eyes or skin. (Note that 10 CFR 850 does not address soluble forms of beryllium. During the rulemaking period, DOE believed that soluble forms of beryllium do not contribute to CBD. Employers are expected, however, to protect workers from the hazards of soluble beryllium as part of their overall worker protection program, such as the program defined in DOE O 440.1A.)

A good source for additional respiratory protection guidance is the DOE Worker Health and Safety Respiratory Protection Program, located at the following website:

<http://www.eh.doe.gov/whs/policy/compliance.html-ssi>

That page provides links to such reference documents as the OSHA Technical Manual, OSHA compliance documents, NIOSH respiratory protection guides, and the Centers for Disease Control and Prevention (CDC) Respiratory Protection Manual.

4.2.9 Protective Clothing and Equipment

Title 10 CFR 850.29 establishes requirements for provision, use, and cleaning of protective clothing and equipment. The use of protective clothing and equipment for beryllium operations must be specified in the CBDPP. Employers must provide clean protective clothing and equipment to beryllium workers and ensure its appropriate use and maintenance where dispersible forms of beryllium may contact the worker's skin or eyes [10 CFR 850.29(a); see 29 CFR 1910.133 (ref. 24) for information about eye and face protection]. Although not covered by 10 CFR 850, employers are expected to protect workers from the hazards of soluble beryllium as part of their overall worker protection program, such as the program defined in DOE O 440.1A. Protective clothing and equipment are required when airborne concentrations of beryllium are at or above the action level or when surface contamination levels are measured or presumed to be at or above the $3 \mu\text{g}/100 \text{ cm}^2$ level. Employers are also required under 10 CFR 850.29(a)(4) to provide protective clothing and equipment to any beryllium-associated workers who request them, regardless of measured exposure levels.

Title 10 CFR 850.29(b) requires employers to comply with the general requirements for PPE in 29 CFR 1910.132 (ref. 25), which address such topics as training for PPE, proper fit of PPE, and the requirement that PPE be provided at no cost to the worker. The type and variety of protective clothing (e.g., coveralls, lab coats, or shoe covers) should be based on the work conditions and expected contamination levels. Typically, a lab coat, gloves, and booties are the minimum protection needed. Additional protective equipment may also be required, depending on the nature of the operation; this could include face-shields, goggles, coveralls, overalls, jackets, footwear, headwear, and gauntlets.

Employers may choose reusable or disposable clothing. Each choice has its benefits and drawbacks. Reusable clothing is more comfortable but presents the potential problem of exposing laundry personnel. The type of clothing chosen may also contribute to the potential for heat stress.

Workers who may get high levels of contamination on their hands should wear gloves that can be removed close to the point of use to reduce the spread of contamination. Open wounds should be sealed with airtight bandages because beryllium contamination causes ulcers that can seriously aggravate the wound.

Title 10 CFR 850.29(c) requires employers to establish procedures for donning, doffing, handling, and storing protective clothing and equipment. Beryllium workers must be prevented from leaving beryllium areas with contamination on their bodies or personal clothing. This includes a requirement that beryllium workers change from their personal clothes into full-body protective clothing and footwear before beginning work in a regulated area. Upon leaving a regulated area, workers should remove protective clothing and discard it as hazardous waste or segregate it with other beryllium-contaminated clothing. Workers should carefully remove and place (not throw) soiled clothing in laundry containers to avoid generating airborne beryllium and unnecessarily contaminating the change room with the beryllium-bearing dust on the clothing. Persons handling soiled clothing should wear high-efficiency respirators, and they should be trained and fit-tested with the proper size respirator. Beryllium-contaminated clothing must be appropriately labeled (see section 4.2.18).

Title 10 CFR 850.29(d) prohibits the removal of beryllium-contaminated protective clothing and equipment from areas that contain beryllium except for laundering, cleaning, maintenance, or disposal. Title 10 CFR 850.29(e) prohibits the removal of beryllium from protective clothing and equipment by means that could disperse beryllium into the air (e.g., blowing or shaking). Employers may use HEPA vacuuming of contaminated protective clothing and equipment as part of the doffing procedure.

Title 10 CFR 850.29(f) gives employers flexibility in determining the frequency for cleaning, laundering, repairing, or disposing of protective clothing based on specific work conditions and the potential for contamination. Beryllium-contaminated clothing and equipment removed for one of these purposes must be placed in containers that will prevent the dispersion of beryllium dust. These containers must be appropriately labeled (see section 4.2.18). Laundry containers should have lids that automatically close behind the deposited clothing. Laundry bags are available that dissolve during the washing process so that laundry workers can avoid the potential exposure that could result from opening the bags and handling the contaminated clothing. (These bags may not be practicable in humid environments.) Other types of plastic bags that are used for laundry should not be reused. All used bags slated for disposal must be handled with other beryllium-contaminated wastes and must be properly labeled (see sections 4.2.12 and 4.2.18).

Employers must notify both on-site laundry workers and off-site contractors who provide laundry services about any beryllium contamination, the hazards associated with the

contamination, and appropriate measures they should take to prevent the release of airborne beryllium and to protect laundry workers.

4.2.10 Housekeeping

Title 10 CFR 850.30 establishes housekeeping requirements for operational areas where beryllium is present. Employers are required to conduct routine surface sampling to determine housekeeping conditions wherever beryllium is present in operational areas of DOE/NNSA facilities, and they must maintain removable surface contamination levels that do not exceed $3 \mu\text{g}/100\text{cm}^2$ during non-operational periods. Removable contamination is defined as “beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing” [10 CFR 850.3(a)].

Surface sampling for housekeeping purposes is not required in non-operational, closed-off rooms or in buildings where workers will not be exposed to beryllium contamination. Likewise, sampling is not required in the interior of installed closed systems, such as enclosures, glove boxes, or ventilation systems [10 CFR 850.30(a)]. DOE’s ORPS, described in DOE O 232.1A and DOE M 232.1-1A, does not require the reporting of surface beryllium (or any non-radioactive chemical) contamination levels that exceed prescribed limits.

Surface monitoring is used to monitor the effectiveness of routine housekeeping and spill-cleanup efforts in a workplace and to help diagnose the sources of beryllium contamination. Monitoring surface contamination levels is an indispensable tool for ensuring that beryllium emissions from operations are under control. The only practical method of monitoring surface levels is to maintain the surface contamination at an established housekeeping level so that elevations above that level can readily be detected. Also, the location and pattern of surface levels obtained from surface monitoring results can help to pinpoint any source of airborne beryllium.

Employers must include goals for housekeeping and cleanliness as part of their exposure reduction and minimization efforts (see section 4.2.5). Employers should minimize accumulations of beryllium dust on surfaces in the workplace. Beryllium contamination on surfaces may become re-suspended and contribute to airborne levels if aggressively agitated. Also, workers in the habit of bringing their hands to their faces may be exposed to airborne beryllium from contamination on their sleeves. Sleeves are likely to become contaminated from contact with contaminated surfaces. However, surface levels should not be used in an attempt to measure worker exposure. Surface sampling results do not quantitatively correlate with personal exposures to beryllium particles that are re-entrained into the air or that are inhaled from workers’ sleeves.

The appropriate use of surface monitoring should be covered in the beryllium exposure assessment plan (see section 4.2.4). Monitoring frequency should be determined using a risk-based approach and can vary from occasional to every shift. Occasional monitoring may be adequate for activities that are not likely to increase surface contamination levels (e.g., activities conducted in administrative areas adjacent to, but not within, an active beryllium work area and small-scale tasks conducted in ventilated enclosures). Frequent monitoring may be appropriate

for activities that are likely to result in high surface contamination levels. For example, both the AWE Cardiff facility and the LANL Beryllium Technology Facility perform surface monitoring at the end of every shift.

Employers should use NIOSH analytical method 9100 (ref. 26) for surface monitoring. This method may have to be modified for surfaces smaller than 100 cm² using a procedure like that described in Appendix D of 10 CFR 835 for radioactive contamination:

When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped.

Employers may use surface sampling methods (e.g., dry wipe sampling) other than NIOSH 9100 but should consider transitioning to the NIOSH method (wet wipe sampling) in a cost-effective manner. DOE believes that the use of a single surface sampling method will reduce result variability across the complex and allow DOE to determine which control methods work best. Comparability of other methods to the NIOSH method should be documented. DOE recognizes that removable surface contamination may build up during a work shift and that the duration of a shift can vary widely for different operations. Surface sampling should be conducted after normal cleanup at the end of a shift and during non-operational periods rather than during the shift. Additional guidance concerning surface sampling (e.g., recommended number and location of swipe samples) can be found by reviewing sampling plans and procedures in documents in the CBDPP Implementation Tool Kit, which can be found on the web at the following site:

<http://www.eh.doe.gov/be/itk.html-ssi>

DOE does not wish to preclude the use of surface sampling techniques other than wipe sampling for measuring beryllium contamination. New technologies may improve current techniques. Direct-reading instruments may provide better results than wipe sampling; beryllium colorimetric screening may improve the utility of wipe sampling by quickly indicating which surfaces are, or are not, contaminated before obtaining the samples. New surface sampling technologies should be validated.

Procedures should ensure that housekeeping practices are performed regularly and thoroughly to prevent the accumulation of beryllium-containing dust and to limit the spread of contamination. Housekeeping can result in worker exposures to beryllium-contaminated dust. Therefore, procedures should also focus on preventing the spread and re-entrainment of dust during the performance of housekeeping activities.

Title 10 CFR 850.30(b) requires employers to use wet cleaning methods, vacuuming, or other cleaning methods that avoid the production of airborne dust. The rule cites the use of “sticky tack cloths” as an acceptable cleaning method. (“Sticky tack cloths” are cloths to which a sticky substance is applied. Particles readily stick to tack cloths.) Wet cleaning methods are likely to capture and retain beryllium particles before they can be dispersed into the air from dusty surfaces. Acceptable methods of wet cleaning include the use of low-pressure water mists

(rather than high-pressure streams that will disperse beryllium particles), power-driven wet scrubber units, HEPA filtered floor buffers, wet floor mops, and wet wipes, sponges, and cloths. Employers should monitor the methods used to ensure that the methods do not become a source of airborne beryllium particles if, for example, the tacky cloths become overloaded or the wet scrubbers begin to leak droplets that contain beryllium particles.

Dry cleaning methods are prohibited for cleaning beryllium-contaminated floors and surfaces. Examples of prohibited dry cleaning methods include shoveling, sweeping, or brushing. The use of these methods is acceptable only in completely closed systems, such as a glovebox, that provide an effective barrier between the beryllium and workers. Another prohibited work practice is the use of compressed air to remove dust-containing particles of beryllium unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the disturbed dust.

Title 10 CFR 850.30(c) requires HEPA filters on portable or mobile vacuum units used to clean beryllium-contaminated areas. HEPA-type portable vacuum cleaners and dedicated central vacuum systems equipped with HEPA filters are the only types allowed in the cleanup of beryllium. The system used for beryllium also may be used for other toxic contaminants as long as all hazards are considered in maintenance of the system and disposal of contaminated filters.

Title 10 CFR 850.30(d) requires employers to ensure that cleaning equipment used to clean beryllium-contaminated surfaces is labeled and controlled, and that it is not used for non-hazardous materials. DOE's intent with these provisions is to prevent the spread of beryllium-contaminated dust and debris onto workplace surfaces and to prevent the release of beryllium into workplace air since equipment such as vacuum cleaners often are a major source of beryllium-contaminated dust and debris.

Dedicated central vacuuming systems that discharge outside after filtration will normally be operating under permits from the local authority for enforcement of the Clean Air Act. The filtration system and the maintenance schedule may be specified in the local authority permit.

Periodic maintenance is critical for vacuum systems. Such maintenance should be conducted on both portable and fixed vacuum systems. Maintenance normally includes pressure drop testing to determine when a filter is clogged and needs to be cleaned or replaced, and aerosol penetration testing to determine that no leaks have developed in or around the HEPA filters. Old filters must be properly labeled and handled as beryllium waste.

Aerosol penetration testing of HEPA filters is also normally done when a new filter is installed to ensure that the unit is correctly positioned and dust is not leaking around the filter. (See section 4.2.5.2, "Engineering Controls, Ventilation" for additional guidance on HEPA filters.) Workers doing filter testing and maintenance have the potential for beryllium exposure, and employers must take appropriate steps to protect them and minimize exposure.

Employers should determine if it would be preferable to conduct cleanup where a spill has resulted in beryllium contamination of an item or to isolate and transport the item to another

location for decontamination. Reasons to transport the item may include lower risk to workers performing the cleanup or better technology resulting in a more effective cleanup process.

4.2.11 Release Criteria

Title 10 CFR 850.31(a) requires employers to clean beryllium-contaminated equipment and other items to the lowest contamination level practicable and label such equipment or items before releasing them to the general public, a DOE/NNSA facility for non-beryllium use, or to another facility for work involving beryllium. The phrase “and other items” covers tools, supplies, documents, etc., but does not include real property or buildings. Before releasing equipment or items to the public or releasing them to DOE/NNSA for use in a non-beryllium area, employers must ensure that—

- removable contamination does not exceed the higher of either $0.2 \text{ } \mu\text{g}/100 \text{ cm}^2$ or the concentration of beryllium in soil at the point of release, whichever is greater;
- the equipment or item is labeled in accordance with 10 CFR 850.38(b); and
- they have obtained the recipient’s commitment to implement controls that will prevent foreseeable beryllium exposure, considering the nature of the equipment or item, its future use, and the nature of the beryllium contamination.

Because beryllium is ubiquitous in soils throughout the United States, background soil accumulating on a surface in a DOE/NNSA facility could contain more beryllium than the release criteria of $0.2 \text{ } \mu\text{g}/100 \text{ cm}^2$ for public or non-beryllium use. Title 10 CFR 850.31(b)(1) clarifies that the release criterion of $0.2 \text{ } \mu\text{g}/100 \text{ cm}^2$ for public or non-beryllium use does not apply to beryllium on equipment or an item due to an accumulation of beryllium-containing background soil.

Large amounts of dust, for which background soil is the source, may have accumulated on equipment or other items, particularly in old facilities. Employers may analyze this dust and determine that it is not covered by the rule because it does not meet the rule’s definition of beryllium if it contains less than 0.1 percent beryllium by weight. Conversely, the beryllium in dust for which beryllium activities was the source would be covered because it meets the rule’s definition of beryllium. (In other words, a surface that is found to exceed $0.2 \text{ } \mu\text{g}/100 \text{ cm}^2$ of removable beryllium immediately after a beryllium activity may not be released for public or non-beryllium use even if several years later the concentration of beryllium in the accumulated dust becomes less than 0.1 percent by weight.)

DOE recognizes that regarding beryllium-containing dusts differently depending on the source of the beryllium may seem contradictory, but this is a consequence of the fact that 10 CFR 850 applies to DOE/NNSA beryllium activities and does not apply to the natural process of deposition of dusts coming from other sources. DOE further recognizes that deposition of sufficient beryllium-containing dust, for which background soil is the source, to exceed $0.2 \text{ } \mu\text{g}/100 \text{ cm}^2$ of removable beryllium, will very rarely occur. The rule provides employers with flexibility in applying 10 CFR 850.31 to the specific conditions of each facility. CBDPPs should include specific definitions of “beryllium-contaminated” materials for the facilities in question

and supporting rationale for those definitions in addressing the rule's release criteria requirements in 10 CFR 850.31.

Guidance for conducting surface sampling (e.g., recommended number and location of swipe samples) can be found by reviewing sampling plans and procedures included in the CBDPP Implementation Tool Kit, which can be found on the web at the following site:

<http://www.eh.doe.gov/be/itk.html-ssi>

Before releasing beryllium-contaminated equipment or items to another facility performing beryllium work, employers must ensure that [10 CFR 850.31(c)]—

- removable contamination does not exceed $3 \mu\text{g}/100 \text{ cm}^2$;
- the equipment or item is labeled in accordance with 10 CFR 850.38(b); and
- the equipment or item is enclosed or placed in sealed, impermeable bags or containers to prevent release of beryllium dust during handling and transportation.

Title 10 CFR 850.31 requirements do not apply to transferring specific beryllium components from one operating area to another at the same site. The purpose of the release criteria requirements is to closely control the potential for beryllium exposure and the spread of beryllium contamination. If beryllium components are to be moved from one operating area to another at the same site, the CBDPP plan should contain procedures for transfers that address the control of exposure and spread of contamination.

Contamination can typically be removed by vacuuming surface dust using a HEPA vacuum and wet-wiping with water containing a wetting agent or an industrial soap. Another effective cleaning technique is to use sticky tack cloths. However, wet-wiping and tacky cloths may not be effective on adsorptive materials, such as porous ceiling tiles or upholstered furniture, which are more readily cleaned using a HEPA vacuum. DOE's "Handbook for Occupational Health and Safety During Hazardous Waste Activities" (ref. 27) contains a thorough discussion of equipment decontamination strategies. Decontamination may have to be repeated several times to reduce beryllium levels below the limits established in 10 CFR 850.31, depending on the equipment's or item's surface characteristics and the chemical and physical form, morphology, and concentration of the beryllium particles. Employers should verify contamination removal using surface sampling techniques such as NIOSH analytical method 9100 (ref. 26) prior to release of equipment or items.

Contaminated internal surfaces of equipment should also be decontaminated. For example, a lathe or other piece of equipment may be free of removable surface contamination, and therefore releasable; however, the same equipment may contain internal dust that could become airborne and present a health hazard to subsequent users (e.g., during repair activities). Such items must be labeled to warn workers who may disassemble them in the future. Examples of appropriate labels are contained in section 4.2.18. On the other hand, a different releasable piece of equipment may contain internal beryllium contamination combined with other substances (e.g., grease), making it unlikely that the beryllium would ever become airborne. The presence

of this type of “non-removable” contamination, even at levels above the removable contamination release criteria, may not necessarily present a health hazard or warrant decontamination. Accordingly, equipment with internal, removable beryllium dust presents a greater potential risk than equipment with internal beryllium dust embedded in grease and the employers must consider those risks to future users before releasing any equipment or item. Section 4.2.2, “Hazard Assessment,” discusses techniques for evaluating risk and should be used to support decision making on release of equipment or other items.

Employers should determine controls or conditions necessary to prevent future beryllium exposure, incorporating them as conditions for releasing equipment or other items. For example, such controls could include a requirement that appropriate safety and health personnel, such as industrial hygienists, be contacted prior to beginning repairs or maintenance on equipment. Documents transferring ownership of items with actual or potential beryllium contamination should inform the new owner of the contamination, steps taken or not taken to clean both internal and external surfaces, surface contamination levels, hazards associated with beryllium exposure, and the controls or conditions necessary to prevent future beryllium exposure. Employers should obtain documentation of the recipient’s commitment to implement the controls that will prevent foreseeable beryllium exposure.

Title 10 CFR 850.31(c)(3) requires employers to ensure that a released item is enclosed or placed in sealed, impermeable bags or containers to prevent exposure to beryllium during handling and transportation to its destination. Enclosure can be accomplished by any practical means such as wrapping in plastic. Labeling of equipment is also a requirement prior to release and should be performed in accordance with 10 CFR 850.38(b) (see section 4.2.18).

4.2.12 Waste Disposal

Title 10 CFR 850.32(a) requires employers to control the generation of beryllium-containing waste, as well as beryllium-contaminated equipment and other items that are disposed of as waste, through the application of waste minimization principles. Beryllium-containing waste, as well as beryllium-contaminated equipment and other items that are disposed of as waste, must be disposed of in sealed, impermeable bags, containers, or enclosures to prevent the release of beryllium dust during handling and transportation. Labeling of all bags, containers, and enclosures used for disposal of beryllium waste must be in accordance with 10 CFR 850.28 (see section 4.2.18).

4.2.12.1 Minimizing Beryllium Waste

The goal of waste minimization is to reduce, to the extent practicable, the amount of hazardous waste generated and subsequently treated, stored, or disposed. Though waste minimization and pollution prevention programs are not an explicit requirement of the rule, waste minimization and pollution prevention programs have been mandated for DOE/NNSA facilities through Executive Order 12856, “Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements” (ref. 28), and Executive Order 13101, “Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition” (ref. 29). Employers should coordinate with personnel responsible for managing waste minimization programs on their sites

to develop specific goals for wastes that contain beryllium. At a minimum, the following waste reduction principles should be reviewed and implemented, if appropriate, for beryllium operations:

- source reduction techniques including—
 - substitution of less toxic materials for beryllium;
 - process improvements (automation, improved equipment, equipment layout changes, new technology) that reduce the quantities of beryllium required, and
 - improved operating practices (operating and maintenance procedures, material handling, inventory control) that improve efficiency and reduce the quantities of beryllium required;
- recycling of beryllium materials through re-use or reclamation; and
- improved treatment methods for beryllium waste.

Appendix B of the Environmental Protection Agency (EPA) “Facility Pollution Prevention Guide” (EPA/600/1-92/088) (ref. 30) addresses waste reduction practices for various industries, including fabricated metal and metal casting, and may be consulted for relevance to a facility’s beryllium operations.

A waste minimization assessment is a useful tool in identifying opportunities for reducing beryllium wastes. Employers may conduct assessments in accordance with the EPA “Waste Minimization Opportunity Manual” (EPA/625/7-88/003, July 1988) (ref. 31). An assessment should begin with a careful review of a facility’s operations and beryllium waste streams and selection of specific areas to be assessed. Next, options with potential to minimize beryllium waste should be developed, screened, and evaluated for technical and economic feasibility. Finally, employers should select and implement the most promising option(s).

4.2.12.2 Beryllium Waste Management

It is possible that beryllium waste or discarded items containing beryllium may be regulated under the Resource Conservation and Recovery Act (RCRA). Generators of solid waste are required by 40 CFR 262.11 to evaluate their wastes at the initial point of generation to determine whether the wastes are hazardous. The Office of Environmental Policy and Assistance (EH-41) has prepared a computer-automated tool to assist in making this determination. It may be obtained at the following web site (go to “tools” and select “RCRA Definitions of Solid and Hazardous Waste”):

<http://www.eh.doe.gov/oepa>

Employers of operations that generate beryllium waste should begin this evaluation by determining whether beryllium-contaminated waste is excluded or exempted from regulation. Criteria given in 40 CFR 261.3, 261.4 (e.g., samples, scrap metals), 260.20, and 260.22 may be used for this determination. For example, 261.3 exempts non-wastewater residues such as slag that result from high-temperature metals recovery processing of certain wastes, when beryllium

concentrations are below 0.010 mg/l. If the beryllium waste is not excluded based on evaluation of these criteria, employers should evaluate whether the waste meets a listing prescribed in subpart D of part 261.

Subpart D of 40 CFR 261 contains four lists of hazardous wastes:

- wastes from non-specific sources (F-listed wastes), such as spent solvents from degreasing operations;
- wastes from specific industry sources (K-listed wastes), such as distillation bottoms from the production of nitrobenzene by the nitration of benzene;
- discarded commercial chemical products, off-specification species, container residues, and spill residues that are considered acute hazardous waste that can cause injury or death with only small exposures (P-listed wastes); and
- discarded commercial chemical products, off-specification species, container residues, and spill residues that are considered teratogenic, carcinogenic, mutagenic, and/or toxic but are not likely to be immediately dangerous to life (U-listed wastes).

Beryllium powder is specifically identified as a P-listed waste in 40 CFR 261.33. This includes beryllium powder that is discarded or intended for discard, such as residue that remains in a container or in an inner liner removed from a container [see 40 CFR 261.7(b) for criteria to determine exclusions for containers]. Employers should also examine the other lists (e.g., F-list, K-list) within Subpart D to determine their applicability.

If a waste does not appear on a listing in subpart D, employers should determine whether the waste exhibits one of the four characteristics found in subpart C of 40 CFR 261. These include ignitability, corrosivity, reactivity, or toxicity. Most beryllium materials are not considered to be ignitable, corrosive, or reactive, and therefore these characteristics can generally be eliminated. The toxicity characteristics of subpart C are determined based on 40 constituents listed in 40 CFR 261.24. Beryllium is not listed as one of the 40 constituents. Nonetheless, employers should still evaluate subpart C criteria for applicability to wastes that contain beryllium compounds.

If it is determined that beryllium-contaminated waste items are regulated as hazardous waste; employers should consult EPA and state regulations for permits and other requirements for hazardous waste treatment, storage, and disposal. These include 40 CFR 262 through 266, 268, and 270. Environmental personnel familiar with applicable regulations should be involved in obtaining any necessary permits and in managing the waste.

In disposing of beryllium-contaminated waste, employers must minimize airborne exposures both to workers during waste handling and to downstream handlers of the waste. Disposing of beryllium-contaminated items as waste may protect workers better, in some cases, than cleaning the item so that it can be reused or recycled. Worker protection takes precedence over waste minimization, but in most situations, both can be achieved simultaneously.

Beryllium-contaminated materials (including waste, scrap, debris, equipment, and clothing) must be disposed of properly and placed in impermeable enclosures, such as sealed bags or containers, and labeled in accordance with requirements of 10 CFR 850.28. The containing and labeling of beryllium waste are considered beryllium operations and must be included in the CBDPP. RCRA requirements on labeling must be followed when beryllium waste is regulated as a hazardous waste.

4.2.13 Beryllium Emergencies

Title 10 CFR 850.33 requires employers to comply with 29 CFR 1910.120(l) for beryllium emergencies related to D&D operations and 29 CFR 1910.120(q) (ref. 32) for beryllium emergencies related to all other operations. This requirement avoids duplication of effort while ensuring consistent and coordinated responses to beryllium emergencies at DOE/NNSA facilities.

Though not stated in the rule, employers must comply with the requirements of DOE O 151.1, COMPREHENSIVE EMERGENCY MANAGEMENT SYSTEM (ref. 33), when this Order is invoked in relevant contracts. It is likely that many beryllium operations are located within facilities that have already established an emergency management program in response to DOE O 151.1 requirements.

Employers should be aware that 29 CFR 1910.120 [Hazardous Waste Operations and Emergency Response (HAZWOPER)] requirements are more restrictive than DOE O 151.1 in some areas, and further actions may be necessary to ensure that beryllium operations are in compliance. For example, HAZWOPER is more restrictive in five emergency response program areas: documentation requirements, emergency response organization, emergency equipment and PPE, training, and medical surveillance. A discussion of these elements, as well as a good overview of HAZWOPER emergency management requirements, can be found in the DOE “Handbook for Occupational Health and Safety During Hazardous Waste Activities” (ref. 27).

The primary emergency management requirements of 29 CFR 1910.120(l) include—

- preparation of a comprehensive emergency response plan as a separate component of the Facility Safety and Health Plan;
- compatibility and integration of the plan with disaster, fire, and/or emergency response plans of local, state, and Federal agencies;
- periodic rehearsal of the plan as part of the site’s training activities;
- periodic review and update of the plan;
- installation of an employee alarm system; and
- implementation of the plan in the event of emergencies.

Emergency management requirements of 29 CFR 1910.120(q) apply to any facility with the potential for a hazardous substance release, including beryllium. Sites that have implemented a program compliant with section 303 of the Superfund Amendments and Reauthorization Act of

1986 (Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. 11003) are considered to have met the requirements of 29 CFR 1910.120(q). Emergency management elements of paragraph 29 CFR 1910.120(q) require an emergency response plan similar to paragraph (l), as well as the following additional requirements:

- emergency response indoctrination briefings to skilled support personnel who may be needed temporarily to perform emergency support work (e.g., mechanized earth moving, crane and hoisting operations);
- training and annual demonstration of competency for specialists who work with and are trained in the hazards of specific substances (i.e., beryllium);
- training based on the duties and functions of each responder of an emergency response organization (e.g., “first responder awareness” level needs to understand beryllium characteristics and associated risks during an incident);
- certification of trainers;
- medical surveillance and consultation of emergency response employees;
- protective clothing and equipment for emergency response personnel (e.g., respirators); and
- post-emergency response operations, including removal of materials or contamination from the site of the incident (e.g., decontamination of equipment or items using techniques discussed in section 4.2.11).

4.2.14 Medical Surveillance

Title 10 CFR 850.34(a)(1) requires employers to establish and implement a medical surveillance program for beryllium-associated workers who voluntarily participate in the program. The medical surveillance program is intended to achieve several goals:

- identification of workers at higher risk from the adverse effects of beryllium,
- prevention of beryllium-induced disease by linking health outcomes to beryllium tasks, and
- early detection of beryllium-induced disease, which allows for early treatment.

Beryllium-associated workers are current DOE/NNSA Federal or contractor workers who are or were exposed or potentially exposed to airborne concentrations of beryllium at a DOE/NNSA facility. This includes, but is not limited to—

- beryllium workers;
- workers whose work histories show they may have been exposed to airborne concentrations of beryllium at a DOE/NNSA facility;
- workers who exhibit signs or symptoms of beryllium exposure and have been removed from beryllium exposure as part of a medical surveillance program;

- workers who worked in the past in a beryllium area in a DOE/NNSA facility, but transferred to another job or another DOE/NNSA facility; and
- workers who self-identify.

The requirements in 10 CFR 850.34 address—

- implementation of a medical surveillance program administered by the SOMD;
- baseline, periodic, and emergency medical evaluations and procedures;
- multiple physician review;
- alternate physician determination;
- information provided to employers and to beryllium-associated workers;
- reporting; and
- data analysis.

Records at many facilities identify some workers known to have been exposed to beryllium. Incidentally exposed workers in the past, however, often were not considered to be at risk for CBD and were not identified as potentially exposed. Workers should be given an opportunity to self-identify as potentially having been exposed to beryllium in the past since historical records may be incomplete. Projects involving beryllium at some facilities had a limited duration, and some workers may recall that they worked on those projects rather than that they worked with beryllium.

Title 10 CFR 850.34(a)(2) requires each employer to designate an SOMD, who is responsible for administering the medical surveillance program.

Title 10 CFR 850.34(a)(3) requires employers to ensure that the medical evaluations and procedures required by the rule are performed by, or under the supervision of, a licensed physician who is familiar with the health effects of beryllium. Although a licensed physician is the appropriate person to supervise and evaluate a medical evaluation, many elements of the baseline and periodic evaluations may be performed by another qualified health care professional under the supervision of a physician who is familiar with the health effects of beryllium. Title 10 CFR 850.34(c) requires employers to establish procedures for follow-up of findings from baseline and periodic examinations.

It is DOE intent that SOMDs manage cases to ensure that workers with positive findings are referred to appropriate physicians for further diagnosis and treatment. It also is DOE intent that workers will be referred to board certified pulmonary or occupational medicine physicians who have the experience, specialized equipment and examination protocols needed to differentiate between CBD and other lung diseases when CBD is a possible cause of the findings. At present, there are relatively few medical centers with experience diagnosing CBD. SOMD's may decide that it is advantageous to support local providers in developing the needed experience if the number of workers requiring referral is sufficiently large.

Symptoms that may indicate the presence of CBD are listed in a discussion of the disease at the following web sites:

<http://www.eh.doe.gov/be/webdoc1.html-ssi>
http://www.ornl.gov/cer/BMSP_pro/be-home.htm
<http://www.njc.org/berylliosis.html>
<http://www.beryllium.org>

Title 10 CFR 850.34(a)(4) requires employers to establish and maintain a list of beryllium-associated workers who may be eligible for medical surveillance. The list must be based on the results of the hazard assessment, exposure records, and other information regarding the identity of the beryllium-associated workers. The list must be adjusted at regular intervals based on the results of the periodic medical evaluations of the beryllium-associated workers.

Title 10 CFR 850.34(a)(5) requires employers to provide the SOMD with the information needed to operate and administer the medical surveillance program. The information includes—

- a list of beryllium-associated workers who may be eligible for medical surveillance;
- the baseline inventory, hazard assessment, and exposure monitoring data;
- the identity and nature of activities or operations on the site that are covered under the CBDPP;
- the related duties of beryllium-associated workers; and
- the type of respirator and PPE used by beryllium-associated workers.

Title 10 CFR 850.34(a)(6) requires employers to provide the SOMD and the examining physician with—

- a copy of 10 CFR 850 and its preamble;
- a description of the worker's duties as they pertain to beryllium exposure;
- records of individual worker's beryllium exposures; and
- a description of the personal protective and respiratory protective equipment used by the worker in the past, present, or anticipated future.

Title 10 CFR 850.34(b) requires employers to provide three types of medical evaluations (baseline, periodic, and emergency) to beryllium-associated workers who voluntarily participate in the medical surveillance program. The evaluations and procedures must be provided at no cost to the worker and at a time and place that is reasonable and convenient to the worker. Participation in the medical surveillance program is not mandatory for workers. A worker has the right to decide not to participate in the medical surveillance program when first offered, but can decide to participate in the medical surveillance program at a later time. Also, a worker who is enrolled in the medical surveillance program has the right to withdraw from the program at any time.

Title 10 CFR 850.34(b)(1) establishes requirements for the baseline medical evaluation. The purpose of the baseline medical evaluation is to—

- establish the current health status of each worker and determine whether it is appropriate to assign the worker to jobs with beryllium exposure,
- initially determine what level of medical surveillance the employer must provide to the particular worker, and
- establish essential baseline data for each worker for assessing subsequent changes in health status attributable to beryllium exposure.

Baseline medical examinations must include—

- a detailed medical and work history with emphasis on past, current, and anticipated future exposure to beryllium;
- a respiratory symptoms questionnaire;
- a physical examination with special emphasis on the respiratory system, skin, and eyes;
- a chest radiograph (posterior-anterior, 14 x 17 inches) interpreted by a NIOSH B-reader of pneumoconiosis or a board-certified radiologist (unless a baseline chest radiograph is already on file);
- spirometry, including the forced vital capacity (FVC) and the forced expiratory volume at one second (FEV1);
- the beryllium lymphocyte proliferation test (Be-LPT); and
- any other tests deemed appropriate by the examining physician for evaluating beryllium-related health effects.

DOE does not require the use of a specific standardized form or questionnaire for the baseline evaluation. However, appropriate standardized forms and questionnaires have been developed, and examples can be found at the following web site:

http://www.ornl.gov/cer/BMSP_pro/be-quest.htm

Use of these forms or similar tools is left to the discretion of the SOMD.

The pulmonary function tests (spirometry) are needed to provide baseline data on lung function and to permit evaluation of any future change in lung function. This information may also be useful in assessing the health of beryllium-associated workers who wear respirators.

Beryllium lymphocyte proliferation testing is highly specialized. The five laboratories that are currently performing this test are listed below.

- Medical Division, Oak Ridge Institute of Science and Education
P.O. Box 117

Oak Ridge, Tennessee 37830
(865) 576-3076

- Cleveland Clinic Foundation
9500 Euclid Avenue, L-15
Cleveland, Ohio 44195
(216) 444-8844
- Division of Environmental and Occupational Health Sciences
National Jewish Medical and Research Center
Denver, Colorado 80206
(303) 398-1723
- Pulmonary Immunology Unit
Hospital of University of Pennsylvania
Philadelphia, Pennsylvania 19104-4283
(215) 573-9890
- Specialty Laboratories, Inc.
Santa Monica, California 90404-3900
(800) 421-4449

These laboratories currently vary somewhat in the Be-LPT procedures that they use. DOE is developing the standard, “DOE Specification, Beryllium Lymphocyte Proliferation Testing (BeLPT),” to minimize these differences. DOE expects this standard to be available by mid-2001 on the DOE Technical Standards web site at—

<http://www.eh.doe.gov/techstds/standard/standfrm.html>

Title 10 CFR 850.34(b)(2) establishes requirements for periodic evaluations. The periodic evaluations must be provided annually to beryllium workers and every 3 years to other beryllium-associated workers. The annual schedule for beryllium workers is intended to give priority for medical surveillance to workers at the greatest risk of exposure. This should ensure that those workers most in need of medical surveillance obtain it as soon as possible so that actions in response to positive medical findings can be taken as soon as possible.

The periodic medical evaluations must include—

- a detailed medical and work history with emphasis on past, present, and anticipated future exposure to beryllium;
- a respiratory symptoms questionnaire;
- a physical examination with emphasis on the respiratory system;
- the Be-LPT; and
- any other tests deemed appropriate by the examining physician for evaluating beryllium-related health effects.

Title 10 CFR 850.34(b)(3) requires employers to provide a medical evaluation as soon as possible to any worker who may have been exposed to beryllium because of a beryllium emergency. The medical evaluation must include the same elements as the periodic evaluation specified in 10 CFR 850.34(b)(2). The SOMD may determine that a medical evaluation of a worker shortly after a beryllium emergency is not necessary if the worker already participates in the beryllium medical surveillance program.

Medical surveillance using traditional screening tests has proven ineffective in detecting CBD in its early stages. A positive Be-LPT in peripheral blood lymphocytes indicates sensitization to beryllium and may be an early sign of CBD. The Be-LPT can be used as a diagnostic test, as a screening test, and as a surveillance tool. The incidence of positive peripheral blood Be-LPT results in exposed workers is considered to be an indicator of the occupational health impacts of beryllium exposure and a method for identifying populations at risk for CBD. A positive Be-LPT in lung lymphocytes combined with granulomas in the lung provides definitive support for a diagnosis of CBD. Many sensitized individuals, as identified by positive results on the Be-LPT, have developed CBD at a future date.

Table 7 presents a schedule of medical surveillance required by 10 CFR 850.34.

Under 10 CFR 850.34(c), employers must establish a multiple physician review process for beryllium-associated workers that allows for the review of initial medical findings, determinations, or recommendations from any medical evaluation conducted pursuant to 10 CFR 850.34. This process—

- strengthens and broadens the bases for medical decisions made pursuant to the rule when a beryllium-associated worker questions the findings or recommendations of the initial physician retained by the employer;
- increases worker confidence in the soundness of the medical findings and recommendations; and
- increases worker acceptance of and participation in the medical surveillance program.

The availability of a multiple physician review process allows workers to exercise their rights in an informed, knowledgeable way. The process allows beryllium-associated workers the opportunity to obtain an independent review of the findings, determinations, or recommendations of the physician selected by the employer. Over time, this independent review is likely to show either that the worker's distrust of the physician retained by the employer is unwarranted or that the employer should improve the quality of medical surveillance being provided. Worker acceptance of, and participation in, the medical surveillance program is likely to be strong if employers administer medical surveillance programs that maintain worker confidence.

A beryllium-associated worker is allowed to designate a second physician to review any findings, determinations, or recommendations made by the initial physician if the employer selects the initial physician to conduct the medical examination or consultation. The second

physician may conduct any consultations, examinations, and laboratory tests that he or she deems necessary to facilitate the review [10 CFR 850.34(c)(1)].

The employer must promptly notify the beryllium-associated worker in writing of the right to seek a second medical opinion after each medical exam or consultation conducted by the initial physician provided by the employer [Title 10 CFR 850.34(c)(2)].

Under 10 CFR 850.34(c)(3), the employer is permitted to make its participation in, and payment for, multiple physician review contingent on the beryllium-associated worker doing the following within 15 days after receiving the initial physician's written opinion or receiving notice of the right to a second medical opinion:

- informing the employer that he or she intends to seek a second medical opinion, and
- initiating steps to make an appointment with a second physician.

The rule has no limitations on a beryllium-associated worker's choice of a second physician, except that the second physician must be a licensed physician who is familiar with the health effects of beryllium.

When the findings, determinations, or recommendation of the second physician differ from those of the initial physician, 10 CFR 850.34(c)(4) requires the employer and the beryllium-associated worker to make efforts to encourage and assist the two physicians in resolving any disagreements. If the two physicians cannot resolve their disagreement, 10 CFR 850.34(c)(5) requires the employer and the worker, acting through their respective physicians, to designate a third physician to resolve the disagreement. The third physician will review the previous findings and recommendations and may conduct any consultations, examinations, and laboratory tests that he or she deems necessary to resolve the disagreement. The third physician should provide a written medical opinion to the SOMD, which will be used to resolve the disagreement between the other two physicians. Title 10 CFR 850.34(c)(6) requires the SOMD to act consistently with the findings, determinations, and recommendations of the third physician, unless the SOMD and the beryllium-associated worker reach an agreement that is consistent with the recommendations of at least one of the other two physicians.

Table 7. Schedule of Medical Surveillance¹

	Baseline Medical Evaluation	Periodic Evaluation²	Emergency Evaluation³
Detailed Medical and Work History Emphasis on past, present, and anticipated future exposure to beryllium	R	R	R
Respiratory Symptoms Questionnaire	R	R	R
Physical Examination	R Emphasis on respiratory system, skin, and eyes	R Emphasis on respiratory system	R Emphasis on respiratory system
Chest Radiograph (posterior-anterior)	R (unless a chest radiograph is already on file)	R (every 5 years)	R (unless a chest radiograph, that is less than 5 years old, is already on file)
Spirometry	R Forced vital capacity and forced expiratory volume at 1 second	D	D
Be-LPT	R	R	R
Other Tests Deemed Appropriate by Examining Physician⁴	D	D	D
R = Required by 10 CFR 850. D = Discretionary component of surveillance to allow individual decisions on the risk versus benefits and because surveillance can be conducted without this procedure.			
¹ For beryllium-associated workers who voluntarily participate. ² Periodic evaluation must be conducted annually for beryllium workers and every 3 years for beryllium-associated workers. ³ The SOMD may determine that a medical evaluation of a worker shortly after a beryllium emergency is not necessary if the worker already participates in the beryllium medical surveillance program. ⁴ For example, tests such as lung lavage-LPT, lung biopsy, or spirometry.			

The employer and the beryllium-associated worker may use an expedient alternate physician determination process in lieu of the multiple physician review process, so long as the alternative protects the worker's health at least as well as the multiple physician review process [10 CFR 850.34(d)]. For example, a jointly agreed upon physician might be used in the first instance without recourse to other physicians.

Title 10 CFR 850.34(e) requires the SOMD to provide the employer with a written, signed medical opinion for each medical evaluation performed on each beryllium-associated worker within 2 weeks of receipt of the results. The written opinion must take into account the findings, determinations, and recommendations of the other examining physicians who may have examined the beryllium-associated worker. The SOMD's opinion must contain—

- the diagnosis of the worker's condition relevant to occupational exposure to beryllium and any other medical condition that would place the worker at increased risk of material impairment as a result of further beryllium exposure;
- any recommendation for removing the worker from DOE/NNSA beryllium activities, limiting the worker's activities or duties, or using PPE (e.g., respiratory protection); and
- a statement that the SOMD or the examining physician has clearly explained to the worker the results of the medical evaluation, including all test results and any medical condition related to beryllium exposure that requires further evaluation or treatment.

The written medical opinion provided to the employer must not reveal any specific records, findings, or diagnoses that are not related to the health effects of beryllium exposure.

Title 10 CFR 850.34(f) requires the SOMD to provide each beryllium-associated worker with a written medical opinion within 10 working days of receiving the results of medical tests or procedures. The written opinion must contain the results of all medical tests or procedures, an explanation of any abnormal findings, and any recommendation that the worker be referred for additional testing for evidence of CBD.

Employers must provide the beryllium-associated worker with the same information that is provided to the examining physician within 30 days of the worker's request.

Title 10 CFR 850.34(g) requires employers to report on OSHA Form No. 200, "Log and Summaries of Occupational Injuries and Illnesses," beryllium sensitization, CBD, or any other abnormal condition or disorder of workers caused by or aggravated by occupational exposure to beryllium. Work-related CBD is a recognized occupational illness. Beryllium sensitization from occupational exposure is an "abnormal condition" that is classified as an occupational illness. Detailed instructions for illness and injury reporting are contained in Chapter (V)(E) of "Reporting Guidelines for Occupational Injuries and Illnesses" (ref. 34). Medical removal is considered to indicate an "abnormal condition." Employers can use such information in determining whether the number of removals in various areas of the plant correlates with exposure levels. In this way, employers can focus attention on areas of the plant where medical removals due to beryllium occur.

Title 10 CFR 850.34(h) requires employers to analyze medical, job, and exposure data routinely and systematically to identify individuals or groups potentially at risk for CBD and to identify working conditions that are contributing to that risk. Employers must determine which workers should be offered medical surveillance and evaluate the need for additional exposure controls based on the results of these analyses. This data analysis provides a component for linking

workplace conditions and health outcomes as required by 10 CFR 850.39(d) (see section 4.2.19) and can be a component of the performance feedback required by 10 CFR 850.40 (see section 4.2.20).

4.2.15 Medical Removal

Title 10 CFR 850.35 establishes the medical removal protection (MRP) and MRP benefits provisions of the rule. It addresses the medical basis for MRP, temporary and permanent removal, worker consultation, return to work, and MRP benefits. Medical surveillance can be effective in protecting workers' health only when workers voluntarily seek medical attention when they feel ill, refrain from efforts to conceal their true health status, and fully cooperate with examining physicians.

Without MRP, employers would be free to maintain workers diagnosed with beryllium sensitivity or CBD in their current jobs, which would not sufficiently protect worker health. Alternatively, employers could choose to terminate workers or transfer them from higher-paying, beryllium-exposed jobs to lower paying, non-beryllium jobs. This might be protective, but it would impair the worker's standard of living. In either case, the effectiveness and integrity of the medical surveillance program would be compromised.

With MRP, beryllium-associated workers are assured of being removed to jobs without beryllium exposure if removal is determined to be necessary to protect their health. With MRP benefits, workers are assured that their normal earnings and job status will be protected for a sufficient period of time if the results of the program require removal from their beryllium-exposed jobs, and if they participate in the medical surveillance program established by the employer as a condition for receiving MRP benefits. This interval allows time for retraining and placement in other jobs.

Title 10 CFR 850.35(a) requires employers to offer beryllium-associated workers medical removal from exposure to beryllium on each occasion that the SOMD determines in a written medical opinion that it is medically appropriate to do so. The SOMD's determination must be based on—

- one or more positive Be-LPT results,
- a diagnosis of CBD,
- an examining physician's recommendation, or
- any other signs or symptoms that the SOMD deems medically sufficient.

Medical removal can be temporary or permanent. Title 10 CFR 850.35(a)(1) requires employers to offer temporary removal pending a final medical determination of the worker's health. Final determination is dependent on the outcome of the multiple physician review process or the alternate medical determination process (discussed in section 4.2.14).

Employers are required to transfer workers who accept temporary removal to comparable jobs for which they are qualified (or for which they can be trained in a short time) and where

beryllium exposures are as low as possible (but in no event above the action level) [10 CFR 850.35(a)(1)(ii)]. Employers must maintain each beryllium-associated worker's total normal earnings, seniority, and other worker rights and benefits until a job becomes available or for 1 year, whichever comes first, if no replacement job is available.

If the final medical determination is that the beryllium-associated worker does not have a medical condition that places him or her at increased risk of material impairment to health from exposure to beryllium, the temporary MRP must be lifted so that the worker may return to his or her normal duties.

Employers must offer permanent medical removal to any beryllium-associated worker specified by the SOMD in a written medical opinion. In such cases, employers must provide workers with MRP benefits [10 CFR 850.35(a)(2)].

Workers need adequate information before they make decisions concerning temporary or permanent removal. For this reason, 10 CFR 850.35(a)(3) requires the SOMD to—

- advise beryllium-associated workers of the determination that medical removal is necessary to protect their health;
- provide workers with a copy of 10 CFR 850, its preamble, and any other information the SOMD deems necessary to illustrate the benefits of removal and the risks of continued beryllium exposure;
- provide workers an opportunity to have any questions about MRP answered; and
- obtain worker signatures acknowledging that they have been advised to accept medical removal from beryllium exposure and have been provided with information on the risks of continued exposure and the benefits of removal.

Title 10 CFR 850.35(a)(4) prohibits employers from returning workers who have been permanently removed for medical reasons to their former job status unless the SOMD determines in a written medical opinion that continued medical removal is no longer necessary to protect their health.

If special circumstances make medical removal an inappropriate remedy, or if the SOMD determines that continued exposure to beryllium will not pose an increased risk to a beryllium-associated worker's health, the SOMD must fully discuss these matters with the worker. The SOMD then may, in a written determination, authorize an employer to return the worker to his or her former job status. The rule permits some flexibility where it is reasonably clear that returning the worker to his or her normal job is unlikely to affect the worker's health and the alternative is much more drastic for the worker. For example, returning a worker to a beryllium-associated job might be justified if, after 2 years of removal, the worker is not experiencing a decrease in lung function, the worker is nearing retirement and termination of employment would mean the loss of pension benefits, and the time the worker will be exposed at or above the action level is very limited (e.g., a few months). In such cases, the SOMD may recommend an employer to provide the worker with additional protection, such as a positive-pressure, supplied-

air respirator. In any event, the decision to return the worker can be made only after the SOMD has fully discussed these matters with the worker [10 CFR 850(a)(4)(ii)]. The SOMD should fully explain to the worker the relevant facts and prognoses.

Title 10 CFR 850.35(b) requires employers to provide medical removal protection benefits for workers who have been permanently removed from beryllium exposure. MRP benefits will encourage worker participation in the medical surveillance program by providing beryllium-associated workers with a reasonable level of assurance that a finding of sensitization or diagnosis of CBD will not lead to the loss of their employment. These benefits include—

- the opportunity to transfer to another position, which is available or later becomes available, for which the worker is qualified (or for which the worker can be trained) and where beryllium exposures are as low as possible, but in no event higher than the action level; or
- a maximum of 2 years of MRP benefits if the worker cannot be transferred to a comparable job where beryllium exposures are below the action level. These MRP benefits are defined as maintenance of total normal earnings, seniority, and other worker rights and benefits as though the worker had not been removed.

If a worker accepts medical removal, the employer must provide the total normal earnings, seniority, and all other worker rights and benefits of a removed beryllium-associated worker as if the worker had not been removed. This requirement is to ensure that a removed worker does not suffer economic loss due to removal. If a removed worker routinely earned overtime pay on the job from which the worker was removed and would have continued to do so during the removal period, then the MRP benefits must include the amount of overtime pay typically earned on the job from which a worker was removed as part of the worker's total normal earnings.

If a removed worker files a workers' compensation claim for a beryllium-related disability, his or her employer must continue to provide MRP benefits pending disposition of the claim. The employer must reduce MRP benefits by the amount of any workers' compensation award received by the worker for earnings lost during medical removal. Similarly, the MRP benefits will be reduced to the extent that the worker receives compensation for lost earnings from a publicly or employer-funded compensation program or from employment with another employer made possible by virtue of the worker's removal. The MRP benefits cannot be reduced because of workers' compensation payments received by the worker for treatment-related expenses. MRP benefits are not intended to expand upon, restrict, or change any rights to a specific job classification or position under the terms of an applicable collective bargaining agreement.

Title 10 CFR 850.35(b)(6) gives employers the authority to make provision of MRP benefits contingent on the worker's participation in the beryllium medical surveillance program. The rule does not require worker participation in the medical surveillance program. However, employers may deny economic protection to workers who are unwilling to participate in medical surveillance.

4.2.16 Medical Consent

Because worker participation in medical surveillance is voluntary, informed consent is necessary to ensure that beryllium workers receive adequate information to make an informed decision regarding their participation [10 CFR 850.36]. Informed consent is not intended as a mechanism for workers to sign away their rights, nor is it a vehicle that employers may use to relinquish their liabilities and responsibilities for providing a safe and healthful workplace.

Employers must provide beryllium-associated workers with a summary of the medical surveillance program at least 1 week before the medical evaluation or procedure or at any time requested by the worker [10 CFR 850.36(a)]. The summary must indicate—

- the type of data that will be collected in the medical surveillance program,
- how the data will be collected and maintained,
- the purpose for which the data will be used,
- a description of how confidential data will be protected, and
- information on the benefits and risks of the medical tests and examinations at least 1 week in advance [10 CFR 850.36(b)].

DOE expects employers to make reasonable efforts to help workers understand the information. For example, workers should receive an explanation of how the Be-LPT works and the possibility for false positive and false negative results. The content and vocabulary of the information should be appropriate to the education level, literacy, and language background of the workers. Workers must be given an opportunity to have their questions answered. An example of the type of information (e.g., questions and answers) needed by the worker to make an informed consent is presented in Appendix D (taken from the preamble).

Employers must have the SOMD obtain a signed, informed-consent form from beryllium-associated workers before performing any medical evaluations or tests [10 CFR 850.36(c)]. Appendix A to 10 CFR 850 contains the required informed consent form, which must be used at all DOE/NNSA facilities. This form may not be modified. The rule does not provide an exemption for the use of this form.

4.2.17 Training and Counseling

Title 10 CFR 850.37 requires employers to develop and implement a beryllium training program for beryllium-associated workers and all other individuals who work at a site where beryllium activities are conducted. Employers must ensure worker participation in the training. Employers are required to develop and implement a counseling program to assist beryllium-associated workers diagnosed by the SOMD to be sensitized to beryllium or to have CBD.

4.2.17.1 Training

The training for beryllium-associated workers must cover the contents of the CBDPP and must address potential health risks to family members and others who may come into contact with beryllium—either on the workers themselves, their clothing, or their personal items as the result of a beryllium control failure at a DOE/NNSA facility [10 CFR 850.37(b)]. This training must be conducted in accordance with 29 CFR 1910.1200, “Hazard Communication” (ref. 35), also referred to as HAZCOM. DOE does not intend for employers to implement separate and redundant training to comply with both 10 CFR 850 and the HAZCOM standard. Rather, DOE expects employers to integrate their CBDPP training into existing HAZCOM training programs, thus minimizing the employers’ burden and providing for a consistent approach to worker training and communication of hazards.

The training provided for all other individuals who work at a site where beryllium activities are conducted must consist of general awareness of beryllium hazards and controls [10 CFR 850.37(c)].

DOE expects employers to conduct training in a manner that is easy to understand so that workers can understand the information and apply it to workplace. Training material should be appropriate in content and vocabulary to the education level, literacy, and language background of affected workers. Employers may wish to consult Appendix E of 29 CFR 1910.1200, which addresses principles for adult education.

The Office of Occupational Medicine and Medical Surveillance (EH-61) has provided a set of materials that employers may use in training workers about the health hazards of beryllium. Those materials can be found on-line at the following web site:

<http://www.eh.doe.gov/med/commbe/>

In addition, two training videos, “Beryllium Disease” (ref. 36) and “Beryllium” (ref. 37), are also available.

Employers may find additional useful information for beryllium training on the DOE CBDPP web site at—

<http://www.eh.doe.gov/be/>

Finally, DOE has published two handbooks on training: DOE-HDBK-1078-94, “DOE Handbook Training Program Handbook: A Systematic Approach to Training” (ref. 38) and DOE-HDBK-1074-95, “DOE Handbook Alternative Systematic Approaches to Training” (ref. 39). These handbooks are available at—

<http://www.eh.doe.gov/techstds/standard/appframe.html>

Employers must provide beryllium training before or at the time of the worker’s initial assignment to the job and at least every 2 years thereafter [10 CFR 850.37(d)]. Employers must also provide retraining whenever they have reason to believe that beryllium workers lack the proficiency, knowledge, or understanding needed to work safely with beryllium. Title 10 CFR 850.37(e) cites two examples of situations that require retraining:

- any new beryllium hazards resulting from a change in operations, procedures, or controls about which the beryllium worker was not previously trained; and
- a beryllium worker's performance involving beryllium work indicates that the worker has not retained the requisite proficiency.

Periodic training should reinforce and update initial training and should not merely repeat initial training. How often training is provided should be determined using a risk-based approach. Examples of situations in which more frequent training would be appropriate include instances when the risk for exceeding the action level is high, the effectiveness of exposure reduction and minimization strategies is marginal or not proven, or activities and processes are complex or highly variable.

DOE has previously issued requirements and guidance on education, training, and skills for many categories of personnel. These include individuals responsible for developing and implementing measures necessary for ensuring compliance with OSHA safety requirements. Some of these requirements are addressed in DOE O 440.1A, **WORKER PROTECTION MANAGEMENT FOR DOE FEDERAL AND CONTRACTOR EMPLOYEES** (ref. 3). This Order establishes training and qualification requirements for technical professionals and management personnel involved with worker protection at DOE facilities. Although these requirements may not be mandatory at a specific site, this information may be useful for all DOE/NNSA facilities in developing training programs and standards for the education, training, and skills appropriate for personnel to achieve compliance with the requirements of 10 CFR 850.

4.2.17.2 Counseling

Title 10 CFR 850.37(f) requires employers to develop and implement a counseling program to assist beryllium-associated workers who have been diagnosed to be sensitized to beryllium or to have CBD. The purpose of this counseling is to communicate to workers information that may help them make important health- and work-related decisions and become aware of administrative activities, such as filing workers' compensation claims. In addition to educating workers about CBD and related medical and career options, counseling can also provide workers diagnosed to be sensitized to beryllium or to have CBD with needed emotional support to deal with the fear, anxiety, anger, and depression they may experience as a result of their diagnosis. Counseling should be developed in consultation with beryllium-associated workers, as well as any labor organizations that may represent these workers for collective bargaining.

The counseling program must provide sensitized and CBD-diagnosed workers with information pertaining to—

- the medical surveillance program;
- medical treatment options;
- medical, psychological, and career counseling;
- medical benefits;

- administrative procedures and workers' rights under workers' compensation laws and regulations;
- work practices designed to limit exposure to beryllium; and
- the risk of continued exposure after sensitization.

In developing the counseling program, employers should consider the following.

- *Medical surveillance program.* Employers must communicate the medical surveillance program established under 10 CFR 850.34, including multiple physician review, alternate physician determination, information provided to the beryllium-associated worker, and any other relevant information regarding what workers with sensitization to beryllium or CBD can expect from the medical surveillance program.
- *Medical treatment options.* Employers must provide workers with information regarding medical treatment options. This information should include a description of associated benefits, risks, possible side effects, etc., to allow workers to make informed decisions regarding their health care.
- *Medical, psychological, and career counseling.* Employers must have the ability to address workers' medical, psychological, and career planning needs by providing appropriate counseling.
- *Medical benefits.* Workers diagnosed as being sensitized to beryllium or as having CBD must be informed of available medical benefits. This information must include a description of medical removal protection benefits, as provided for under 10 CFR 850.35, that assures workers that, if the results of medical surveillance require them to be removed from their beryllium-exposed jobs, their normal earnings and job status will be protected for the time periods specified in the rule (see section 4.2.15).
- *Administrative procedures and workers' rights under workers' compensation laws and regulations.* Employers must inform workers of their rights and the administrative procedures under applicable workers' compensation laws and regulations. Contractor Benefits Administrators and Loss Control Managers are key resources to assist in providing this counseling. Employers may advise workers to consult with their own attorneys on these matters. Workers' compensation laws vary from state to state for private employees. Federal employees are covered by the Federal Employees' Compensation Act (FECA), which provides for workers' compensation coverage administered by the Office of Workers' Compensation Programs (OWCP), Division of Federal Employees' Compensation within the Department of Labor, Employment Standards Administration. Additional FECA information and resources are available at—

<http://www.dol.gov/dol/esa/public/regs/compliance/owcp/fecacont.htm>

Additional state workers' compensation information is available by contacting the applicable state workers' compensation official listed at—

<http://www.dol.gov/dol/esa/public/regs/compliance/owcp/wc.htm>

- *Work practices designed to limit exposure to beryllium.* Employers must counsel employees about work practices designed to limit exposure. These include following procedures for regulated areas, hygiene facilities and practices, respiratory protection, protective clothing and equipment, housekeeping, beryllium emergencies, and warning signs and labels (see sections 4.2.6, 4.2.7, 4.2.8, 4.2.9, 4.2.10, 4.2.13, and 4.2.18).
- *Risk of continued exposure after sensitization.* Employers must inform workers of the risk of continued exposure after sensitization. It is medically prudent to prevent additional exposure to beryllium once sensitization has occurred.

Employers may implement the counseling program through several different options, including one-on-one counseling with a physician or other counselor and coordination of support groups to provide a forum for sensitized and CBD-diagnosed workers to discuss issues with the support of peers with similar concerns and obtain information from invited experts. Employers may supplement these options with use of printed material (e.g., fact sheets or brochures) to provide information to workers.

Employers may find information that can be useful for the counseling program on the DOE CBDPP web site at—

<http://www.eh.doe.gov/be/>

and in the DOE Training Reference for Beryllium Workers and Managers/Supervisors entitled, “Communicating Health Risks, Working Safely With Beryllium,” May 1998, found at—

<http://www.eh.doe.gov/med/commbe/>

Support groups for sensitized and CBD-diagnosed workers are identified at—

http://www.dimensional.com/~mhj/support_groups.html

4.2.18 Warning Signs and Labels

Title 10 CFR 850.38 requires employers to (1) post warning signs at each access point to beryllium regulated areas and (2) affix warning labels to containers of beryllium, beryllium compounds, or beryllium-contaminated items. Proper exposure control of beryllium requires that its presence be clearly identified to all who might possibly be exposed. The purpose of the warning signs and labels is to ensure that all affected individuals, not only those previously identified as potentially exposed to beryllium, are apprised of the potential hazards of beryllium exposures. The posting of signs serves as a warning to workers who may otherwise not know they are entering a regulated area where beryllium exposure may occur.

Regulated areas, as discussed in section 4.2.6, may often exist on a temporary basis, such as during maintenance, D&D operations, or in emergency situations. The use of warning signs under these circumstances is of particular importance because maintenance, D&D, or an emergency could present new or unexpected potential for exposure to workers who are regularly expected to conduct work unrelated to beryllium at these locations. All access points to regulated areas must be clearly identified with warning signs containing the following information:

<p style="text-align: center;">DANGER BERYLLIUM CAN CAUSE LUNG DISEASE CANCER HAZARD AUTHORIZED PERSONNEL ONLY</p>
--

In addition to posted area signs, all containers of beryllium, beryllium compounds, beryllium parts, or beryllium-contaminated clothing, waste, scrap, or debris must have a prominent warning label. These provisions must conform to OSHA’s “Hazard Communication” standard (ref. 35). The label must convey the following information:

DANGER
CONTAMINATED WITH BERYLLIUM
DO NOT REMOVE DUST BY BLOWING OR SHAKING
CANCER AND LUNG DISEASE HAZARD

Employers must also consider the potential for internal contamination of equipment (see section 4.2.11). In some cases, internal beryllium contamination would not pose a health hazard unless the equipment is disassembled. Additional labeling should be used to alert workers of the potential hazard. Examples of such labels include—

CAUTION
BERYLLIUM CONTAMINATION
INHALATION OF DUST OR FUMES MAY CAUSE
SERIOUS CHRONIC LUNG DISEASE

This equipment was known to have been used for beryllium operations and may be internally contaminated. If the internal components of this equipment are breached, workers must be protected in accordance with applicable OSHA standards. Surveys were performed to determine the levels of external surface contamination. Survey results are packaged with the equipment.

Adequate communication and content with an emphasis on visibility and wording effectiveness is necessary to inform workers of beryllium's potential to cause serious disease. Detailed specifications for warning signs and labels, such as size, color, or other physical attributes, must conform to the requirements of 29 CFR 1910.145. Employers are responsible for designing, producing, and using signs and labels of appropriate size, color, contrast, etc., so that they are easily visible to workers. OSHA's "Hazard Communication" standard [29 CFR 1910.1200(f)(9)] states that "employers having employees who speak other languages may add information in their language to the material presented, as long as the information is presented in English as well."

4.2.19 Recordkeeping and Use of Information

Title 10 CFR 850.39 requires employers to establish and maintain accurate records of all beryllium inventory information, hazard assessments, exposure measurements, exposure controls, and medical surveillance. The Heads of DOE/NNSA elements (typically the operations office manager or DOE/NNSA facility manager) must designate beryllium records as "agency records" that must be retained for a minimum of 75 years. The employer must convey to DOE or its designee all records required under 10 CFR 850 if the employer ceases to be involved in the CBDPP [10 CFR 850.39(c)]. Successive employers should use consistent record retrieval identifiers to ensure that records of interest are readily available.

DOE/NNSA field element personnel with CBDPP responsibilities should work with DOE/NNSA contracting officers to ensure that solicitations and contracts contain a local specialized clause

discussing the records to be maintained by the contractor pursuant to the Privacy Act notice published by the Department in the Federal Register. The provisions that apply to this clause are—

- Title 48 CFR (FAR) 52.224-1, Privacy Act Notification;
- Title 48 CFR (FAR) 52.224-2, Privacy Act;
- a local specialized clause, Privacy Act Records, discussing systems of records maintained by the contractor pursuant to the Privacy Act notice published in the Federal Register by the Department; and
- for Management and Operating contractors, 48 CFR (DEAR) 970.5204-79, “Access to and Ownership of Records.” Paragraph (b)(1) of DEAR 970.5204-79 accepts from the list of contractor-owned records “those records described by the contract as being maintained in Privacy Act systems of records.”

Title 10 CFR 850.39 also requires employers to—

- Link data on workplace conditions and health outcomes to establish a basis for understanding the beryllium health risk³ (see section 4.2.14);
- ensure the confidentiality of all work-related CBDPP records;
- maintain all records required by 10 CFR 850 in current and accessible electronic systems⁴ that include the ability to retrieve data readily in a format that maintains confidentiality;
- transmit all records generated as required by 10 CFR 850 to the DOE Assistant Secretary for Environment, Safety and Health on request in a format that protects the confidentiality of individuals; and
- semi-annually transmit to the DOE Office of Epidemiologic Studies an electronic registry of beryllium-associated workers.

Title 10 CFR 850.39 also contains several confidentiality requirements concerning medical information. Individual medical information generated by the CBDPP must be—

- included as part of the worker’s site medical records and maintained by the SOMD or by another physician designated by the employer;
- maintained separately from other records; and

³An example of linking data on workplace conditions and health outcomes is the epidemiological study described in Kreiss et al., “Machining Risk of Beryllium Disease and Sensitization with Median Exposures Below 2 µg/m³” (ref. 40).

⁴DOE recognizes that some records (e.g., X-ray films) cannot effectively be maintained in electronic format.

- used or disclosed by the employer only in conformance with applicable laws (e.g., the Americans with Disabilities Act, the Privacy Act of 1974, and the Freedom of Information Act).

To maintain confidentiality of records, employers must ensure that all records transmitted to other parties do not contain names, social security numbers, or any other information that could be used to identify particular individuals.

DOE must, to the maximum extent allowed by law, make available to the public all records required by 10 CFR 850, while preserving essential confidentiality, consistent with the Freedom of Information Act (FOIA) and Privacy Act. Should the agency receive a request for these records, it will use every argument legally and reasonably available to it, including the authority granted under the FOIA and the Privacy Act and the agency's regulations implementing those statutes, to protect the privacy of individuals in the records generated by the CBDPP.

The agency's policy when it receives a FOIA request is to release responsive records that it is not obligated to withhold. Further, the agency releases, on a discretionary basis, those records it is authorized to withhold (by one or more of the nine exemptions to the general obligation to release government records in response to a FOIA request), where the agency reasonably foresees that disclosure would not be harmful to an interest protected by the exemption(s) authorizing the withholding.

Exemption 6 of the FOIA authorizes the withholding of information of a personal nature such as personal medical records. That kind of information is not the kind of information ordinarily considered appropriate for discretionary FOIA disclosure. And, where personal information is contained in a Privacy Act system of records—which is the case with the medical records generated by the CBDPP—making a discretionary FOIA disclosure of this kind of information is fundamentally incompatible with the Privacy Act. Thus, discretionary disclosure of this kind of information is not made.

Records maintained in a Privacy Act System of Records are generally not available to third parties without the consent of the individual to whom those records pertain. There are exceptions to this rule, however, such as disclosure to those within the agency for necessary, official purposes; to Congress (but not to a member of Congress acting on his or her own behalf or on behalf of a constituent); to an individual upon a strong showing of compelling circumstances affecting the health and safety of that individual; etc. Disclosure under these exceptions is generally permissible and is exercised for any of the enumerated purposes only when the agency deems that disclosure is appropriate and consistent with the letter and intent of the Privacy Act and official interpretations of it.

Title 10 CFR 850.39(h) requires employers to transmit an electronic beryllium registry semi-annually to the DOE Office of Epidemiologic Studies within the Office of Environment, Safety and Health. The registry must include, but is not limited to, a unique identifier, date of birth, gender, site, job history, medical screening test results, exposure measurements, and results of referrals for specialized medical evaluations.

DOE will use the registry to determine the exposure profile and disease status of groups of beryllium-associated workers and to provide feedback to employers on the overall effectiveness of CBDPPs. The registry will give DOE the ability to combine data from different facilities and perform analyses that are impossible to perform with the small amount of data available from each individual facility. Research studies using the registry will provide very important information about beryllium disease and working conditions for groups of workers, but not for individual cases of CBD. Individual cases must be followed by the SOMD. Appendix E discusses the registry in greater detail. The following web site provides a link to the current “Beryllium-exposed Worker Registry Data Collection and Management Guidance”:

<http://www.eh.doe.gov/epi>

This registry guidance contains the detailed data fields and data dictionary that comprise the registry’s four files.

Title 10 CFR 850.39 requires employers to establish and maintain accurate records of all beryllium inventory information, hazard assessments, exposure measurements, exposure controls, and medical surveillance. Specific information generated from CBDPP activities and required by 10 CFR 850.39 is discussed in various sections of this Implementation Guide, including sections 4.2.1, “Baseline Beryllium Inventory”; 4.2.2, “Hazard Assessment”; 4.2.4, “Exposure Monitoring”; 4.1.5, “Exposure Reduction and Minimization”; and 4.2.14, “Medical Surveillance.”

4.2.19.1 Beryllium Inventory Information

Section 4.2.1.4 of this guide describes the beryllium inventory information that must be documented. Employers should consider documenting and maintaining the following additional information: facility and process descriptions including diagrams, cost codes that link workers to tasks that involve beryllium, the strategy used in determining that the baseline is comprehensive, and explanations of why the spaces and processes not shown in the baseline are unlikely to contain beryllium hazards.

4.2.19.2 Hazard Assessments

Employers must document and maintain hazard assessments, which should include methods, assumptions, conclusions, and recommendations.

4.2.19.3 Exposure Measurements

Employers must document and maintain exposure measurements, which should include—

- exposure group information: personal and unique identifiers, job, task, location, whether the worker is current or former, whether the worker has had known exposures or potential incidental exposures, and other information that can be used to link beryllium exposure information to individuals and medical records;

- exposure monitoring: dates, locations, chemical and physical characteristics and morphology of beryllium contaminants, methods, results, the type of respiratory protective equipment worn, the identity of workers and exposure groups monitored, and indication of whether the purpose of the monitoring was to characterize personal exposure or characterize a process;
- investigative reports of accidental releases or unexpectedly high monitoring results; and
- worker concerns and occurrence reports that indicate breaches in the worker protection program that may have resulted in worker exposures.

4.2.19.4 Exposure Controls

Employers must document and maintain information about exposure controls in use, which must include—

- records of individuals who enter regulated areas: name, date, time entered and left, location, activities performed in the area, and respirator and PPE worn; and
- types of control methods in use, including design and measured levels of control.

4.2.19.5 Medical Surveillance

The physician responsible for medical services should outline procedures for creating and maintaining a medical record for each worker who is identified as exposed or potentially exposed to airborne beryllium. Employers are required to maintain medical monitoring records for all workers subject to the beryllium medical surveillance program. Medical records should include the following:

- copies of the attending physician's written reports,
- a copy of the worker's occupational medicine history,
- results of all medical tests including additional tests recommended by the physician,
- a description of any worker medical complaints that may be related to beryllium exposure,
- diagnoses,
- worker's and group exposures,
- work histories, and
- original X-ray films.

4.2.19.6 Cases of CBD

Cases of CBD must be investigated and reported in accordance with DOE O 231.1, ENVIRONMENT, SAFETY, AND HEALTH REPORTING (ref. 41), when this Order is referenced in the employer's contract. One goal of this investigation report is to create CBD

case descriptions that can be grouped for analysis. The narrative portion of investigation reports should include—

- a work history collected through a review of personnel records and an interview;
- a summary of exposure records, which should include descriptive statistics such as range, mean, standard deviation, or alternatively, percent of action levels exceeded; and
- a characterization of the clinical stage of the disease, such as alveolitus, granuloma, or fibrosis and whether treatment has been prescribed.

4.2.20 Performance Feedback

Title 10 CFR 850.40 requires employers to conduct periodic analyses and assessments of monitoring activities, hazards, medical surveillance, exposure reduction and minimization, and occurrence reporting data. Employers must give the results of these analyses and assessments to line managers, planners, worker protection staff, medical staff, workers, and labor organizations representing beryllium-associated workers who request such information. DOE intends for this information to be available to maintain and continuously improve all elements of the CBDPP.

4.2.20.1 Performance Measurement

Performance measurement is necessary to determine whether CBDPP goals are being achieved and to provide feedback to help understand, manage, and improve CBDPP implementation. The performance measurement process consists of determining what to measure, identifying data collection methods, and collecting data. An overview of this process, as well as performance assessment, can be found in DOE G 120.1-5, GUIDELINES FOR PERFORMANCE MEASUREMENT (ref. 42). Additional general information on goals and performance measures can be found in DOE's TRADE organization's "How To Measure Performance: A Handbook of Techniques and Tools" (ref. 18).

Employers should use both outcome and output measures to determine the effectiveness of CBDPP elements and achievement of program goals (e.g., exposure reduction and minimization). Outcome measures are an assessment of the results of a program activity or effort compared to its intended purpose. Possible CBDPP outcome measures include—

- exposure level measures for groups and individuals, such as arithmetic means or percent exceeding the PEL, the action level, or detection limits;
- incidence of CBD and beryllium sensitization;
- number of workers potentially exposed;
- percent of surface wipe samples outside operational areas exceeding the housekeeping limit;
- area (square feet) outside operational area with removable surface contamination greater than a level identified in the CBDPP,
- beryllium-contaminated waste (cubic feet), and

- results of analyses of occurrence reports.

Output measures are the tabulation, calculation, or recording of an activity or effort and can be expressed in a quantitative or qualitative manner. These measures do not necessarily indicate direct causal relationship for program outcomes, but can be useful indicators of program elements that may contribute to poor performance and undesirable outcomes. Output measures that are potentially useful in managing the implementation of a CBDPP include the following percentages of—

- scheduled hazard assessments completed per month,
- beryllium-associated workers participating in scheduled medical surveillance per month,
- beryllium-associated workers completing scheduled hazard communication training per month,
- site workers completing scheduled general employee beryllium awareness training per month,
- the site facilities that have completed baseline inventories and sampling per month, and
- beryllium-associated workers who received personal monitoring that were targeted for this monitoring in the site's CBDPP.

4.2.20.2 Performance Assessment

Evaluating the performance of the CBDPP consists of periodic program assessments and routine surveillance (i.e., analysis) of program elements. Assessments should be coordinated with, but not replaced by, DOE independent oversight inspections or annual evaluations. Program assessments should focus on organizations at all levels (department, division, section, individual workers, and subcontractors) and should involve an open reporting process (i.e., without fear of reprisal). Employers should tie assessments to CBDPP performance measures and should involve assessment methods, such as visual monitoring of work processes, review of beryllium process and hazards data, procedural reviews, and worker qualification and training reviews. Assessments should be conducted at least annually, although 10 CFR 850.40 does not specify a minimum frequency for conducting assessments.

Surveillance is closely related to performance assessment but includes routine analyses with the goal of identifying potential problems where intervention can improve performance. The following is a formal definition of occupational health surveillance (ref. 43):

Occupational health surveillance entails the systematic monitoring of health events and exposures in working populations in order to prevent and control occupational hazards and their associated diseases and injuries. Occupational health surveillance, like all public health surveillance systems, has four essential components:

1. To gather information on cases of occupational diseases and injuries and on workplace exposures;

2. To distill and analyze the data;
3. To disseminate organized data to necessary parties, including workers, unions, employers, governmental agencies, and the public; and
4. To intervene on the basis of data to alter the factors that produced these health events and hazards.

Medical surveillance analyzes health and clinical data for higher-than-expected incidence or sentinel events, such as CBD diagnoses or beryllium sensitization, to determine if corrective actions can prevent a recurrence. Physicians providing medical surveillance should be familiar with working conditions, have access to exposure information, have the authority to report findings and make recommendations directly to line management, and deliver summaries and impacts of medical surveillance results to appropriate personnel. Beryllium training should include this medical surveillance information.

Similarly, exposure surveillance includes the routine analysis of exposure data with the aim of identifying occupational exposures that require additional control. Exposures that do not comply with the PEL must be investigated to determine their cause and to determine corrective actions to prevent a recurrence. Control charts of beryllium exposure levels and other analytical tools can be used to identify working conditions requiring further investigation.

4.2.20.3 Feedback and Improvement

Active performance feedback mechanisms are essential for day-to-day implementation and continual improvement of each element of the CBDPP. Useful feedback can best be achieved by having a multidisciplinary team collaborate on current beryllium issues. Such teams should include representatives of line management, workers, maintenance, and safety functions. “Plan of the Day” meetings or other daily or weekly project and operations meetings involving team members are essential in providing real-time feedback on work plans, standard operating procedures, safety issues, or performance problems. Post-job interviews and meetings also yield important insights that can be factored into subsequent work activities.

Another important feedback mechanism is “lessons learned.” These include good work practices or innovative approaches that are captured and shared to improve work, as well as adverse work practices or experiences that should be shared to avoid their recurrence. A systematic process for the collection and dissemination of lessons learned information should be established. Sources of lessons learned information include—

- project summary reports,
- injury and illness reports,
- occurrence reports,
- DOE safety notices, and
- DOE Safety and Health Bulletins.

DOE-STD-7501-95, “Development of DOE Lessons Learned Programs” (ref. 44), and DOE-HDBK-7502-95, “Implementing U.S. Department of Energy Lessons Learned Programs” (ref. 45), provide further information on collecting lessons learned. The following web site provides information and links dealing with DOE’s Lessons Learned program:

<http://www.eh.doe.gov/ll/>

Another critical element of continuously improving performance is a systematic method for tracking corrective actions. This activity is consistent with the objectives of “hazard abatement tracking” as discussed in DOE G 440.1-1, **WORKER PROTECTION MANAGEMENT FOR DOE FEDERAL AND CONTRACTOR EMPLOYEES GUIDE FOR USE WITH DOE O 440.1** (ref. 46). Computerized information systems are a good tool for systematically organizing corrective actions, assigning responsibility, and tracking the completion or delay of any actions. Information should be easily retrievable and routinely monitored and updated.

Examples of beryllium-related information that should be tracked include—

- descriptions of surveillance or assessment findings such as program deficiencies (e.g., inadequate beryllium controls, poor monitoring practices, lack of worker involvement);
- date and location of findings;
- descriptions of and planned completion dates for corrective actions;
- identification of the organization and individuals responsible for corrective actions; and
- identifying numbers for tracking corrective actions.

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